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FISH & GAME DEPARTMENT

John R. Woodworth, Director

FEDERAL AID TO FISH AND WILDLIFE RESTORATION

ST. JOE RIVER CUTTHROAT TROUT AND NORTHERN SQUAWFISH STUDIES

Annual Completion Report

Project F-60-R-2

Job No. 1. Life History of St. Joe River Cutthroat Trout (
Research)
March 1, 1970 to February 28, 1971

by

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JOB COMPLETION REPORT RESEARCH PROJECT SEGMENT

State of Idaho

Project No. F-60-R-2

Job No. 1

Name: ST. JOE RIVER CUTTHROAT TROUT AND NORTHERN SQUAW-FISH STUDIES (RESEARCH)

Title: Life History of St. Joe River Cutthroat Trout Research

Period Covered: March 1, 1970 to February 28, 1971

ABSTRACT

In recent years the size and number of cutthroat trout (Salmo clarki) harvested from the St. Joe River have declined. To discover the extent of the problem and its probable causes, I examined the life history, abundance, population structure and harvest of cutthroat trout. By comparing catch-effort, observed abundance (snorkeling counts), length and age compositions of harvest, and survival rates of cutthroat from heavily and lightly-fished river sectors, and considering recent increases in fishing pressure, the extraordinary vulnerability of cutthroat, population dynamics of the species and reports relating over-fishing and declining cutthroat stocks, I concluded that over-fishing caused the recent deterioration of the fishery.

Unless we reduced the mortality rate of cutthroat trout in the river, it seemed likely that the stock would become economically if not biologically extinct in the near future. When given a choice, 88 percent of 292 anglers interviewed while fishing the St. Joe River, preferred to save the cutthroat, even though severe harvest restrictions might be necessary, rather than continue the liberal bag limit (15 fish per day and no size limit) and gradually replace cutthroat with hatchery-reared rainbow trout (Salmo gairdneri). In an attempt to reduce mortality and maximize angler and human satisfaction (by providing " quality fishing"

and preserving gene pools of native stocks to maximize future options), the Idaho Fish and Game Department revised angling regulations on the upper St. Joe River to include a trophy-fish fishery for cutthroat trout.

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INTRODUCTION

Overfishing probably caused the recent declines in the number and size of cutthroat trout (Salmo clarki) harvested from the St. Joe River. At the turn of the century, El Hunt (1952) considered the St. Joe River (Figure 1) one of the finest trout streams in America. From 1901 to 1905, the Courier, local newspaper of St. Maries, Idaho, frequently reported catches of seven to nine-pound trout, and fishing trips when anglers caught 50 to 100 "speckled trout", averaging three to five pounds, in a few hours (interviews with "old timers" and inspection of old photographs supported my assumption that the newspaper referred to cutthroat trout).

Cutthroat trout populations have been virtually eliminated from many river systems throughout the West. The recent decline in the average size and number of cutthroat harvested from the St. Joe River indicated that we might be overexploiting this stock. This study 1/ was designed to assess the extent of the problem, ascertain its probable causes, and recommend plausible management alternatives. To accomplish these objectives, I investigated the life history, population structure, abundance and distribution of cutthroat trout in the St. Joe River, and assessed opinions of anglers (regarding the fishery) who fished the river.

1/ Dingell-Johnson Project F-60-R-1.

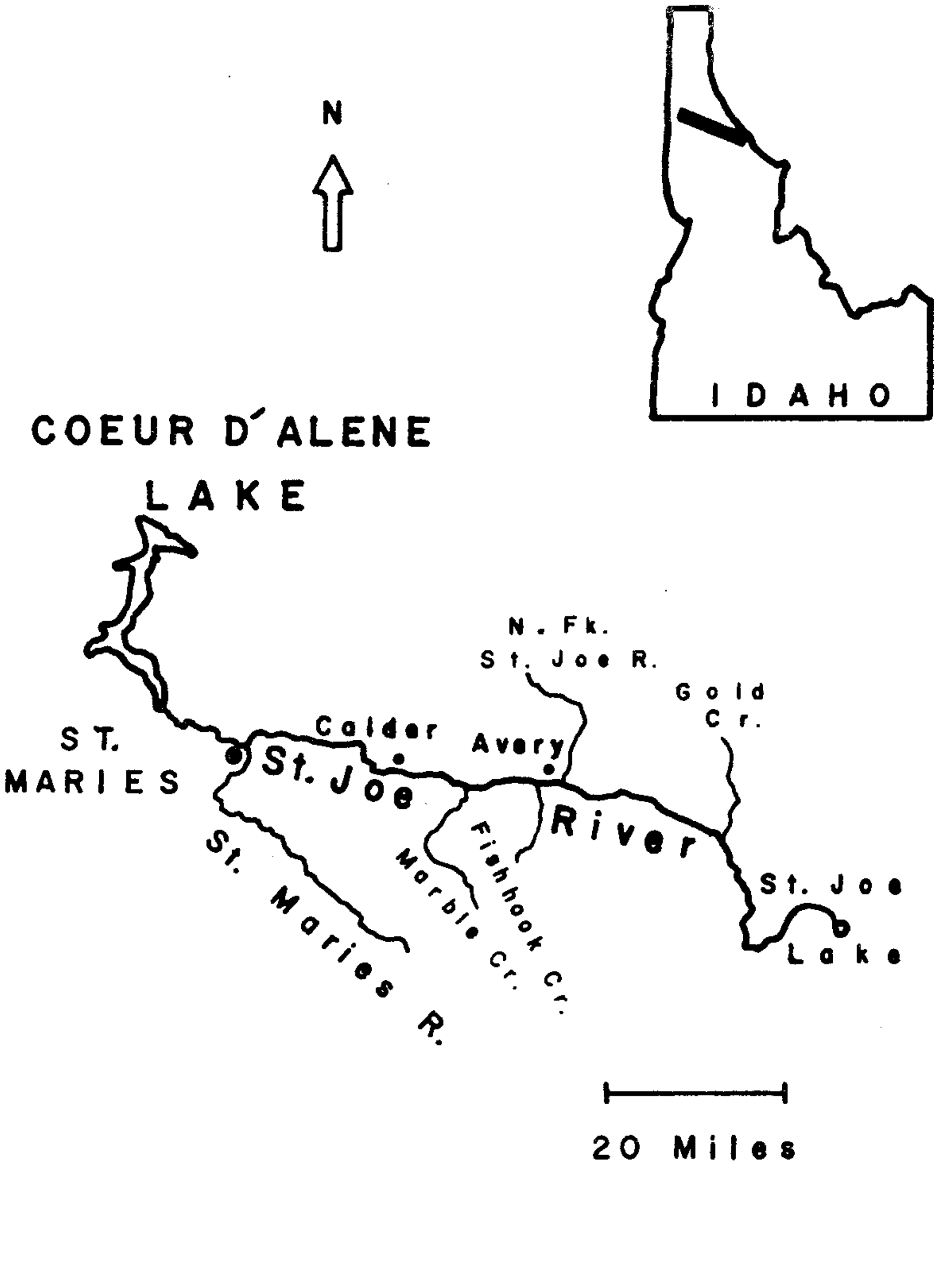


Figure 1. The St. Joe River, Idaho

DESCRIPTION OF STUDY AREA

The St. Joe River originates in the Bitterroot Mountains near the Idaho-Montana border and flows northwest 137 miles through the St. Joe National Forest, before emptying into the southern tip of Coeur d' Alene Lake (Figure 1). I divided the river into four study sectors but conducted most of my research on the upper three (Figure 2).

In its upper reaches, the river flashes over rocky substrates through deep mountain gorges, but in the lower stretches, it glides slowly through tree-lined meadows. Most of sector four is a picture-book stream with alternating rapids and long deep pools. Stream width and pool depth average about 10 and 2 meters (m) respectively, in this sector. The lower part of sector four and sectors two and three consist of many shallow riffles and flat stretches, and several pools which range from 2-6 m deep. Many stretches have an abundance of shallow, flat areas and few pools. Water temperatures ranged from 0 C in winter to 18 C in mid-August, and diurnal fluctuations averaged about 8 C in mid-summer.

Construction of Post Falls Dam in 1906 created a slackwater area in the lower 26 miles of the river. Mid-channel depths and widths of the slackwater area averaged 9 and 80 m respectively, and mean discharge of the river at Calder (about 20 miles below Avery) averaged 2,342 cubic feet per second (Falter, 1969). Davis (1961) described this area in detail.

The lower three sectors received substantial fishing pressure because a road paralleled the river, and many campgrounds dotted the landscape in these sections. Sector four was accessible only by foot,

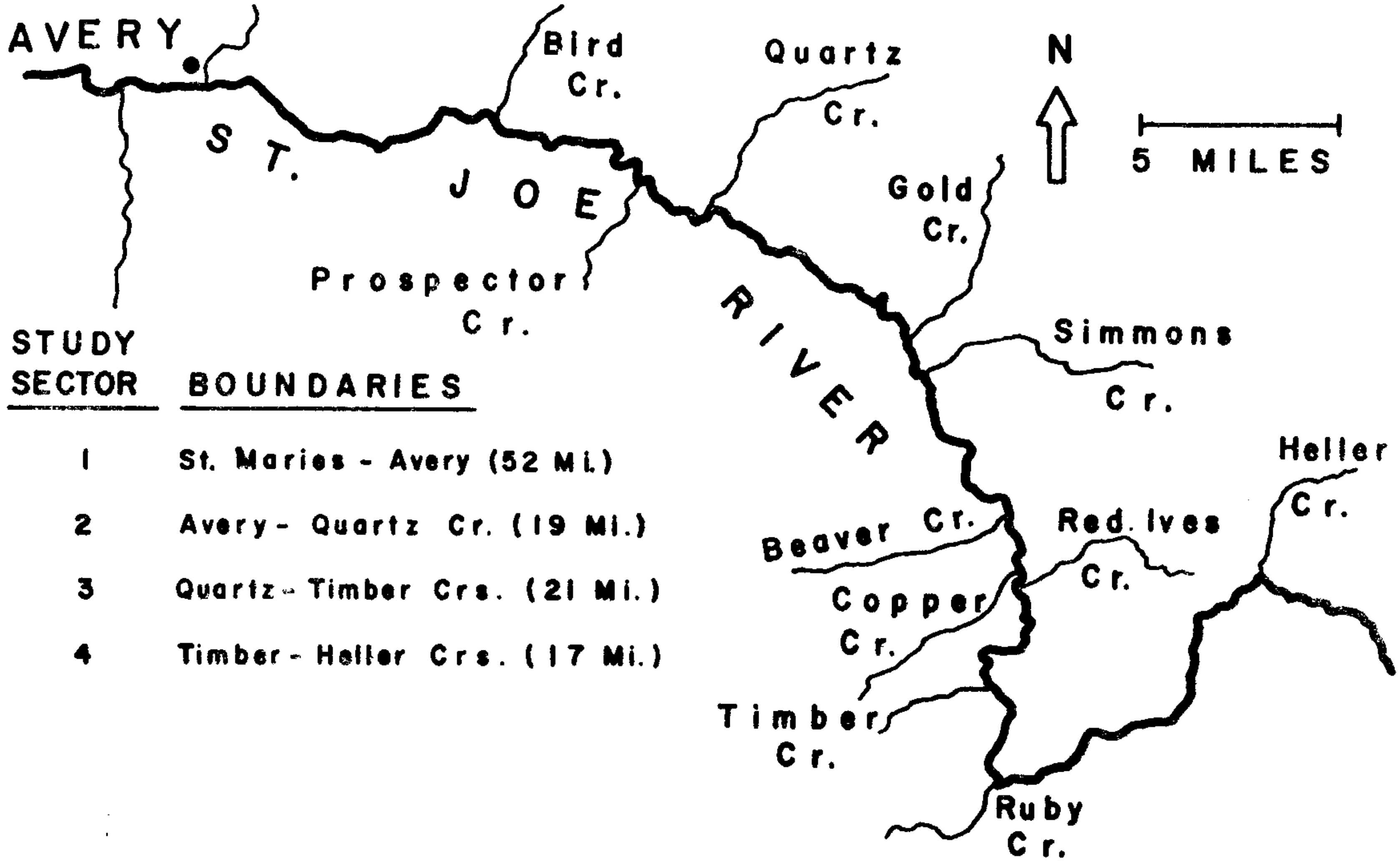


Figure 2. Study sectors on the St. Joe River (sector one extends downstream, 52 miles, to St. Maries).

hrse or trail bike and consequently received less angling pressure. The greatest angler-density occurred in sectors two and three.

Three groups (based on migratry behavior) of cutthroat trout in-habit the drainage. Averett (1963) described adfluvial (resides in lake and spawns in tributaries) and fluvial (resides in main river and spawns in tributaries) races. Data collected in my study indicate that some cut-throat spent their entire lives in tributaries.

Project personnel sampled fish populations in the river and its major tributaries. The density of cutthroat trout in the main river progressively increased from sectors one to four, and with few exceptions, we found more cutthroat in the upper reaches of sidestreams than in the lower two miles. We collected brook trout (Salvelinus fontinalis) and coho salmon (Oncorhynchus kisutch) fry in the lower tributaries (lower half of sector one), rainbow trout (Salmo gairdneri) x cutthroat hybrids in the lower sections of many sidestreams in sectors one to three, and numerous sculpins (Cottus sp.) from most streams in all sectors.

The river supports large populations of mountain whitefish (Prosopium williamsoni) and sculpins (Cottus sp.) above Avery, and northern squawfish (Ptychocheilus oregonensis) and suckers (Catostomus sp.) below Avery. Yellow perch (Perca flavescens) and some sunfish in-habit the slackwater section. The Idaho Fish and Game Department annually released rainbow trout "catchables" and cutthroat trout fry, fingerlings, and "catchables" to supplement the harvest of native cut-throat. Rainbow x cutthroat hybrids, and possibly interacial cutthroat hybrids, have resulted from these plantings.

METHODS

I collected information on abundance and population structure to assess the extent and probable causes of the cutthroat decline; conducted a creel census and angler opinion survey to ascertain catch statistics and angler preferences regarding the fishery; and compiled general life history information including age-growth, maturity, spawning and movement patterns of cutthroat trout. I arranged applicable data to illustrate differences between, and temporal changes within river sectors.

Movements and seasonal migration of trout

I assessed movements of cutthroat and rainbow trout with two downstream-migrant traps and by tag-recapture methods. One trap functioned in and near the mouth of Cold Creek during August and September, 1969, and the other operated in and near the mouth of Beaver Creek during a similar period in 1970.

Project personnel tagged and released trout in the river and tributaries in each sector from June through September of each year. We tagged fish with circular, monel-metal jaw tags, and recorded tag numbers, total lengths (TL) of fish released, and dates and locations of all fish released and recovered. I posted signs along the river to notify anglers where to send or take recovery information.

Of 2101 cutthroat tagged, I received 154 usable returns during the two-year period (Table 1) . I divided returns into those from fish tagged and recovered in the main river, and those from fish tagged in tributaries, and recovered either in tributaries or the main river (emigration). As did Bjornn and Mallet (1964), who conducted a tagging study on the Middle

Fork of the Salmon River, Idaho, I considered cutthroat recovered within one mile of their respective release sites as not having moved.

Table 1. Numbers of cutthroat trout tagged and recovered in the St. Joe River drainage during 1969 and 1970.

Year	Numbers tagged		Usable returns	
	River	Tributaries	River	Tributaries
1969	293	730	29	4
1970	609	469	77	44
Subtotals	902	1199	106	48
Totals	2101		154	

Relative abundance

I established 28 snorkeling transects in sectors two, three and four, drifted them 12 times during the study (in July, August and September, 1969, and in March, April, July, August and September, 1970), and recorded numbers and approximate sizes of cutthroat trout, white-fish and squawfish seen. The transects (either pools or deep runs) were selected for their favorable habitat and large fish-holding capacities. I marked the boundaries of each transect with yellow stakes, and attached photographs and wrote descriptions and locations of each on appropriate forms. Reid (unpublished) 2/ counted transects and furnished abundance data from sector one.

Because transects did not represent the whole river area, and be-cause they had similar dimensions in each river sector (Table 2), I used "fish per transect" rather than "fish per unit length of stream" values

2/ Reid, G., Idaho Cooperative Fishery Unit, Moscow, Idaho.

to compare abundance differences between, and temporal changes within sectors. Similar counts in the future should reveal any significant changes in the abundance of the three species.

Table 2. Mean dimensions of snorkeling transects in each river sector.

Sector	No. of transects	Mean length (m)	Mean width (m)	Mean depth (m)	Mean area (m^2)	Mean volume (m^3)
1 1/	56	113	3	1.5	339	509
2	14	67	8	2.0	536	1072
3	11	48	6	2.0	288	576
4	3	48	9	1.2	432	518

1/ Data for sector one from Reid (unpublished).

Creel census

I contacted numerous anglers to obtain information on the catch, catch-effort, distribution of angling effort and angling methods in the four river sectors, and to procure data on maturity, length-frequency and age-growth (from scales) of cutthroat in the catch. The contacts occurred mainly on weekends and holidays to maximize efficiency. I compared my data with those of Dunn (1968), who conducted a creel census on the St. Joe in 1968.

Age-growth of cutthroat

From 377 cutthroat of various lengths (including 53 fry), I se-cured scales from the caudal peduncles (one to four rows above the lateral line), where scales first form (Averett, 1963; Cooper, 1970; Brown and Bailey, 1952). With the aid of an 81-power scale projector, I aged each fish, referring to the guidelines in Bennet (1967), Lagler (1956) and Ricker (1968), and with occasional consultation. I empirically assessed early scale development of the cutthroat fry.

I examined 19 cutthroat which measured between 39-48 millimeters (mm) and found that fry formed scales at a total length of about 45 mm (Table 3). Cutthroat formed scales at lengths of 41-43 mm in Yellowstone Lake (Laakso and Cope, 1956), at 36 mm in Chef Creek, Vancouver Island (Cooper, 1970), and at 45 mm in various tributaries of the St. Joe River (Averett, 1963).

Table 3. Total length at which cutthroat trout from the St. Joe River form scales.

	TL (mm)									
	39	40	41	42	43	44	45	46	47	48
No. fish with scales	0	0	0	0	0	0	3	-	3	2
No. fish without scales	2	2	2	2	2	1	0	-	0	0

I ranked the anterior scale radii into 4 mm divisions, placed each fish aged in its corresponding group, calculated the means for each group, and fed these values into an IBM, 360 computer (FORTRAN 4, polynomial regression program) to obtain the best body-scale fit.

A second degree polynomial best fits the body-scale relationship of cutthroat trout in the St. Joe River (Figure 3). Cooper (1970), Fleener (1952), Laakso and Cope (1956), and Irving (1955) reported curvilinear body-scale relationships for cutthroat, and Cooper noted that some investigators have incorrectly fitted a straight line to curvilinear, body-scale data. I used the regression equation to back calculate lengths at each annulus.

Because cutthroat emerge at different times and grow at various rates during their first summer, they may or may not form an annulus at

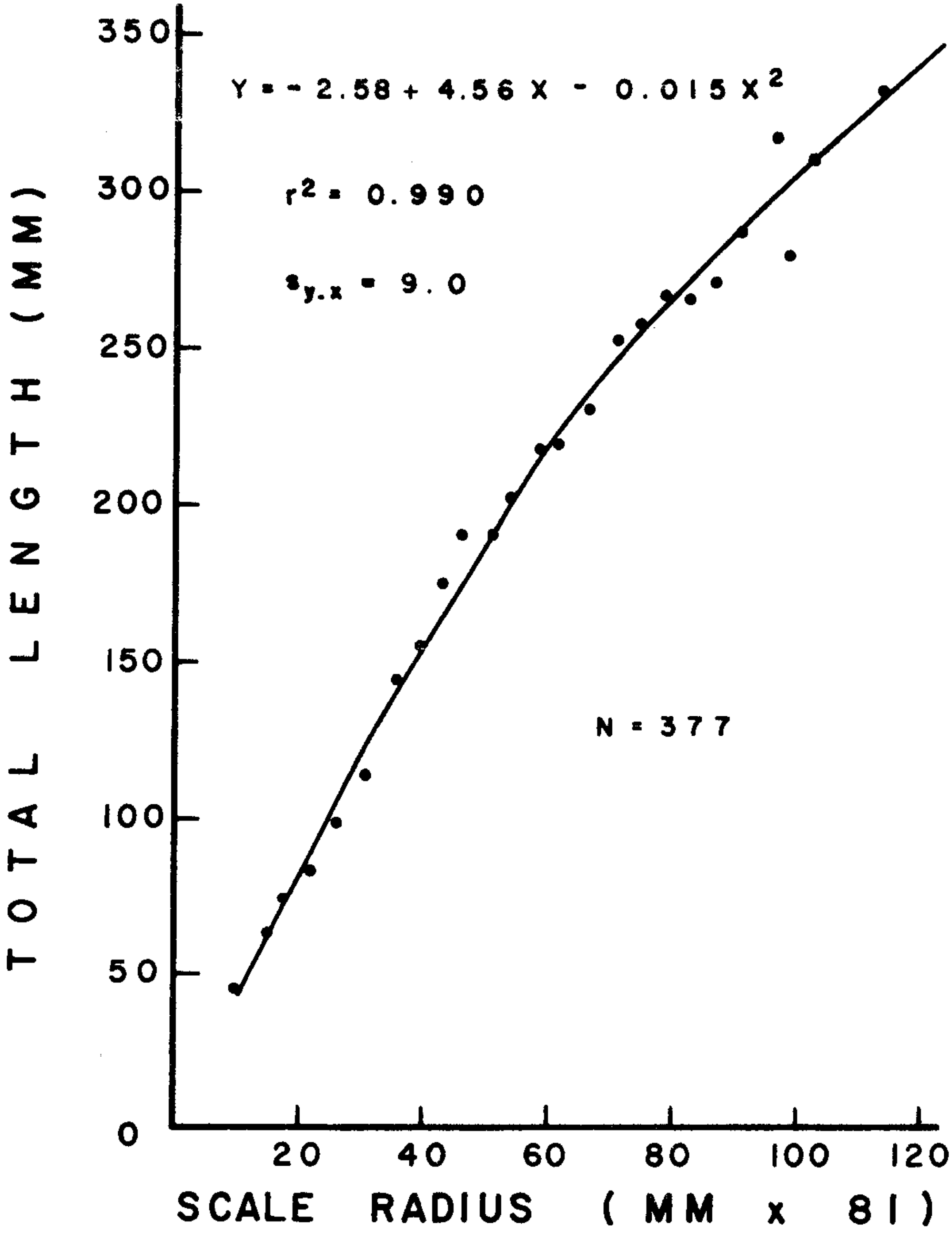


Figure 3. Body-Scale relationship of cutthroat trout in the St. Joe River.

the end of the first growing season (Brown and Bailey, 1952; Laakso and Cope, 1956). Many investigators have resolved the resultant problem of aging fish (by means of the scale method) by classifying cutthroat on the basis of circuli numbers within the first recognizable annuli. If circuli within these year marks did not exceed pre-determined numbers, most researchers considered the annuli as having formed after the first growing seasons. If circuli numbers within the first discernible annuli surpassed the delineated figures, they considered the year marks as having formed after subsequent seasons (Table 4). In addition to circuli numbers, we can use focal size and the shape of the first few circuli as criteria for identifying types of scale development (Laakso and Cope, 1956).

Table 4. Maximum number of circuli which could occur within the first recognizable annulus, to consider that annulus as having formed after the first growing season.

Source	Location	Maximum No. circuli
Laakso and Cope, 1956	Yellowstone L., Wyo.	6
Robertson, 1947	Two mountain lakes, Wyo.	5
Mallet, 1961	Mid. Fk., Salmon R., Ida.	11
Fleener, 1952	Logan R., Utah	9
Averett, 1963	Upper St. Joe R., Ida.	6
Averett, 1963	Lower St. Joe R., Ida.	11
This study, 1971	Upper St. Joe R., Ida.	6

Averett (1963) found that cutthroat fry from the upper St. Joe River had no more than six circuli. I collected 24 fry from the same area in late August through mid-September, 1970, and noted no more than five circuli. I assumed that another circulus could form before the fish would lay down an annulus, and used six as the maximum number which could occur within an annulus formed after the first growing season. Like Laakso and Cope, I also considered focal size and circuli shape in assessing scale development.

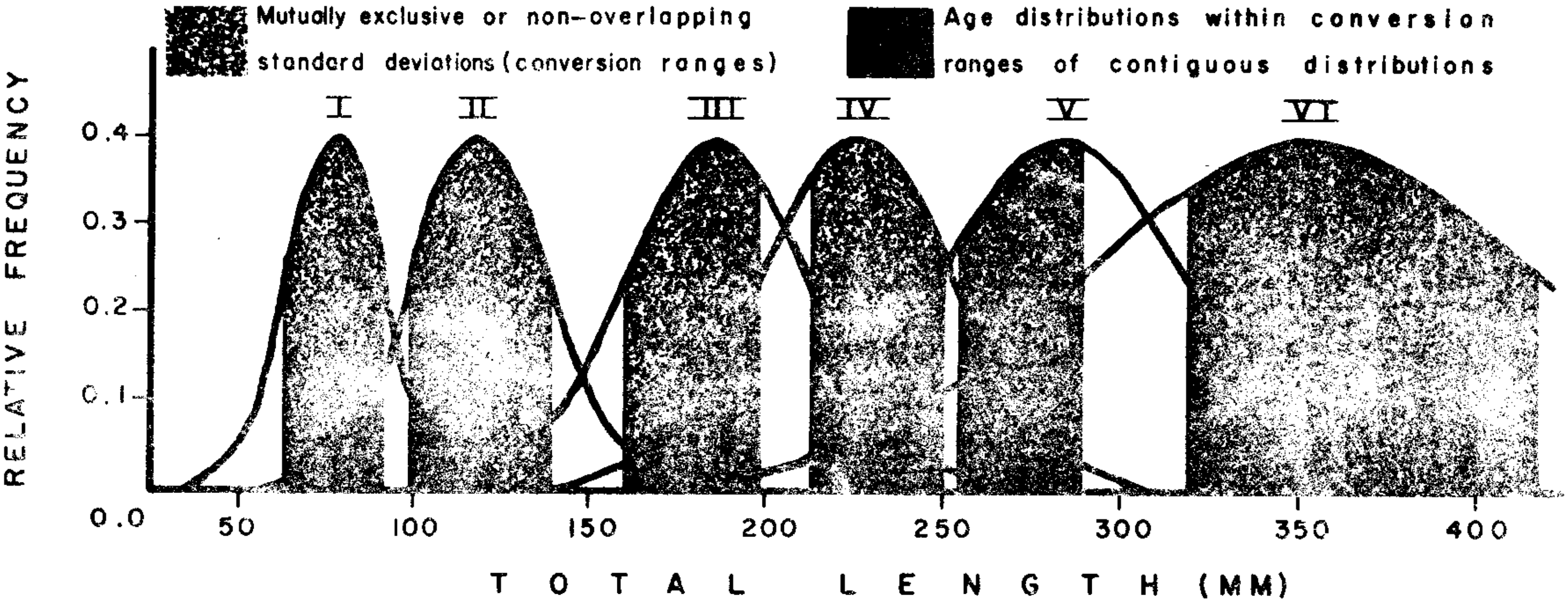
By observing the width of and spacing between circuli and annuli, I ascertained how many years cutthroat spent in tributaries before they migrated to the main river.

Maturity of cutthroat

Using Nikolsky's (1963) classification of maturity stages as a guide, I categorized cutthroat mature (had spawned or would spawn the subsequent spring) or immature, by gonadal inspection. During the latter parts of the two summers, I inspected the size and state of gonads from 89 males and 92 females of various sizes.

Age structure and mortality of cutthroat populations

To utilize the large length-frequency samples from lightly and heavily-fished river sectors, I converted length compositions of the catch to their respective age-frequencies, using age-growth data to compute the mean TL at capture of each age class. Because distributions of lengths within age classes overlapped with those of adjacent age classes, I calculated the standard deviation around each mean, and used only those lengths in mutually exclusive standard deviations, and in non-coincident parts of overlapping standard deviations, in the con-version process (Figure 4; Table 5).



	64–92	99–139	160–197	214–250	255–288	319–417
I	68%	7%	—	—	—	—
II	9%	68%	2%	—	—	—
III	—	3%	52%	15%	1%	—
IV	—	—	16%	51%	15%	—
V	—	—	0.5%	14%	36%	16%
VI	—	—	0.5%	5%	10%	70%
TOTAL	77%	78%	71%	85%	62%	86%

Figure 4. Length-frequencies of age classes aged with conversion ranges (in the lower table I list percentages of each age distribution which are contained in conversion ranges of respective and contiguous distributions).

Table 5. Total lengths of cutthroat trout used to convert catch-frequencies by length, to catch-frequencies by age.

Age class	Sample size	Mean TL at capture (mm)	Standard deviation	Conversion limits (TL in mm)
I	53	78	13.9	64-92
II	27	119	20.1	99-139
III	128	187	26.4	160-197
IV	125	226	27.9	214-250
V	32	285	34.2	255-288
VI	8	353	64.2	319-417

From the computed age-frequencies, I calculated instantaneous mortality rates (i) according to Rounsefell and Everhardt (1953), and found corresponding annual mortality and survival rates (a and s respectively) in Ricker's (1958) table of exponential functions and derivatives (Table 6).

Table 6. Calculation of the instantaneous mortality rate (i), annual mortality rate (a) and annual survival rate (s) from the age-frequency distribution of cutthroat trout caught from sectors two and three of the St. Joe River in 1969.

Age (y)	Age frequency (f)	Log of age frequency (log f)	Log of f(y) 1/ minus log of f(y-1)	(i) 2/	(a) 3/	(s) 3/
I	0					
II	75					
III	231	2.363612				
IV	86	1.934498	0.429	0.988		
V	35	1.544068	1.390	0.898		
VI	5	0.698970	0.845	1.946		
				1.277	0.721	0.279

1/ Negative sign dropped after subtraction

2/ Individual (i)'s = 2.3026 x log of f(y) minus log of f(y-1). Total (i) = mean of the individual (i)'s.

3/ From Ricker's (1958) table of exponential functions and derivatives.

Before I could justifiably compare age distributions and mortality rates of cutthroat populations from lightly and heavily-fished sectors, I had to be reasonably certain that fish had similar growth rates in both sections. Results of a t-test at various probability levels (Table 7), led me to believe that cutthroat populations had similar growth rates in lightly and heavily-fished areas.

Table 7. t-test to discover if cutthroat trout grew at different rates in lightly and heavily-fished sectors of the St. Joe River in 1969 and 1970.

H_o : No difference in growth rates

	Age class					
	I	II	III	IV	V	VI
$\bar{X}_a - \bar{X}_b$	7.8	15.2	2.3	4.9	33.4	93.2
s_d	4.6	8.6	5.3	6.5	14.5	30.9
df	51	25	126	123	30	6
Computed t	1.70	1.77	0.43	0.75	2.30	3.02
Probability of larger t	0.1-0.05	0.1-0.05	0.9-0.5	0.5-0.4	0.05-0.03	0.03-0.01

Using the calculated age frequencies, I estimated the percentage of mature females in cutthroat populations in lightly and heavily-fished sectors. I assumed all fish matured at age class V (TL of 255 mm), and that a 1:1 sex ratio existed.

Cutthroat populations in tributaries

By snorkeling and fishing in several heavily-fished tributaries, and in one (Red Ives Creek) which had been closed to fishing for several years, but was opened to anglers in 1970, I assessed the effects of fishing on size and abundance of cutthroat trout in small streams. Catch-effort, length-frequency and relative abundance information collected from the streams, supplemented data gathered by project personnel in an *inventory* of the main tributaries in the drainage.

Angler *opinion* survey

Project personnel interviewed about 300 anglers on the St. Joe during the 1970 season. We recorded the name, address and approximate age of each angler, and asked them several questions regarding the St. Joe River fishery. I compiled the responses to pertinent *questions* to assess general angler attitudes. The questions and responses are presented in a subsequent section.

RESULTS

Movements and seasonal migration of trout

Most cutthroat were recovered during the same year as released, *within* one mile of respective release sites (Table 8).

Table 8. Numbers of cutthroat trout recovered at various distances from release sites in the same and subsequent years to tagging.

No. miles between release and recovery sites	Nos. tagged and recovered in same year	Nos. tagged in 1969 and recovered in 1970
5+ Upstream	2	1
1-5 Upstream	2	1
Within 1	68	7
1-5 Downstream	9	1
5+ Downstream	5	1

Tag returns indicate that cutthroat moved downstream in fall, upstream in spring and early summer, and moved little during July and August (Table 9). Seventy-one percent (5) of all cutthroat tagged in July and recovered in September and October, moved downstream, but only 11% (7) of those tagged and recovered during June through August, moved down-stream. Thirty-three percent (2) of those tagged in June and recovered in subsequent months, moved upstream, but only 5% (4) of those tagged no earlier than July and recaptured in subsequent months, moved up-stream. Eighty percent (44) of all cutthroat tagged and recovered in July and August had not moved. The maximum distance moved by any cut-throat recovered was 60 miles (two downstream migrants recovered in October).

Table 9. Movements of cutthroat trout in the main stem of the St. Joe River, as assessed by comparing dates and locations of fish recovered in the same year tagged.

Month tagged	Movement from release site	Nos. & percentages recovered in Jul.	Aug.	Sep.	Oct.
Jun.	Upstream 1/	.33(2) 4/			
	None 2/	.67(4)			
	Downstream 3/				
Jul.	Upstream	.09(1)	.08(3)		
	None	.82(9)	.82(32)	.40(2)	
	Downstream	.09(1)	.10(4)	.60(3)	1.0(2)
Aug.	Upstream				
	None		.60(3)		
	Downstream		.40(2)		

1/ Recovered more than one mile upstream from release site.

2/ Recovered within one mile of release site.

3/ Recovered more than one mile downstream from release site.

4/ Percentage (decimal value) and number (in parenthesis) of fish recovered.

Bjornn and Mallet (1964) and Ball (unpublished) [3] observed similar movements by cutthroat in the Middle Fork of the Salmon River, Idaho and the North Fork of the Clearwater River, Idaho, respectively. Miller (1957), on the other hand, reported that cutthroat in Gorge Creek, Alberta, spent their entire lives in home ranges no longer than 20 yards.

Returns from cutthroat tagged in tributaries (57 returns from 1199 tagged fish) indicate that these side-streams support non-migratory races (resident stocks) in their upper reaches (at least three miles above stream mouths), and at least some migratory indi viduals (fluvial and possibly some adfluvial) in their lower sections. Of 161 fish tagged and released at least three miles up tributaries, nine were recovered in the same area as released, but none were re-covered from the main river. Of 13 cutthroat (nine returns of tagged fish and four caught in a downstream-migrant trap) which migrated from tributaries, eight measured 130-142 mm, and 12 were either age II or III. Five of the nine tagged fish moved upstream, and the other four went downstream when they reached the main river (Table 10).

Huston (1970) reported that 70-75% of cutthroat trout spent two years, and 24-28% spent three years in Hungry Horse Creek before migrating to Hungry Horse Reservoir (a hydro-electric impoundment on the South Fork of the Flathead River, Montana). Emigration occurred throughout the summer, but peaked during early July. Bjornn (1961) and Averett (1963) also found that most adfluvial cutthroat in Priest

3/ Ball, K., Idaho Cooperative Fishery Unit, Moscow, Idaho.

Table 10. Cutthroat migration from tributaries to the St. Joe River.

Fish no.	When & where released	When & where recovered	TL when tagged (mm)	Age class	Movement in river
1	8-14-69 20 yds up Gold Cr.	9-13-69 Near Prospector Cr.	197	III	Downstream 15 mi
2	8-17-69 20 yds up Gold Cr.	7-16-70 Near Prospector Cr.	151	III	Downstream 15 mi
3	8-4-70 ¼ mi up Gold Cr.	9-1-70 Near Simmons Cr.	188	III	Upstream 1 mi
4	8-27-69 ½ mi up Beaver Cr.	7-30-70 ¼ mi abv Beaver Cr.	135	II	Upstream ½ mi
5	8-18-69 1 mi up Simmons Cr.	8-70 Near Copper Cr.	139	II	Upstream 7 mi
6	8-18-69 1 mi up Simmons Cr.	8-14-70 Near Prospector Cr.	136	II	Downstream 16 mi
7	8-14-69 ½ mi up Bird Cr.	6-14-70 20 yds up Bird Cr.	142	II	N/A
	6-14-70 1/ 20 yds up Bird Cr.	8-18-70 Near Prospector Cr.			Upstream 2 mi
8	8-12-69 1 mi up Bird Cr.	8-23-70 1 mi abv Prospector Cr.	136	II	Upstream 3 mi
9	8-8-69 ½ mi up Setzer Cr.	8-19-70 Near Fishhook Cr.	130	II	Downstream 5 mi
10	N/A	9-19-70 Beaver Cr.	133	II	None 2/
11	"	"	131	II	"
12	"	"	92	I	"
13	"	"	113	II	"

1/ This fish was recaptured twice.

2/ Trapped while migrating from Beaver Cr.

and Coeur d'Alene Lakes, respectively, spent two or three years in streams before they migrated to lakes.

Planted rainbow trout moved little in the St. Joe River. Three of 114 tagged in 1969 were recovered in 1970; and 12 of 14 fish recaptured in 1969 had moved less than one mile from release sites.

Relative abundance of cutthroat, whitefish and squawfish

During summer counting periods, I usually observed three to four times more cutthroat per transect in sector four (about 7-32 fish per transect) than in sector three (approximately 2-9 fish per transect), three to four times as many cutthroat in sector three than in sector two (approximately 0.2-3.5 fish per transect), and three to eight times as many in sector two than in sector one (about 0.1-1.2 fish per transect) (Figure 5).

Abundance of cutthroat decreased from early to late summer in all stream sectors in 1969 and 1970 (Figure 5). I saw few cutthroat in late September, when water temperatures seldom rose above 6 C. Apparently they had migrated downstream and/or had moved into the rocky substrate to spend the winter. I observed no cutthroat during March and April counting periods.

In each stream sector I saw more cutthroat and more large cut-throat (at least 300 mm) per transect, in 1969 than in 1970 (Figure 6).

Mountain whitefish comprised a majority of fish biomass and interacted with cutthroat for food and space in sectors two, three and four of the St. Joe River. Whitefish numbers increased throughout the summer in these sectors, and reached maximum concentrations of 84 fish per transect in sector two during late September, when they congregated

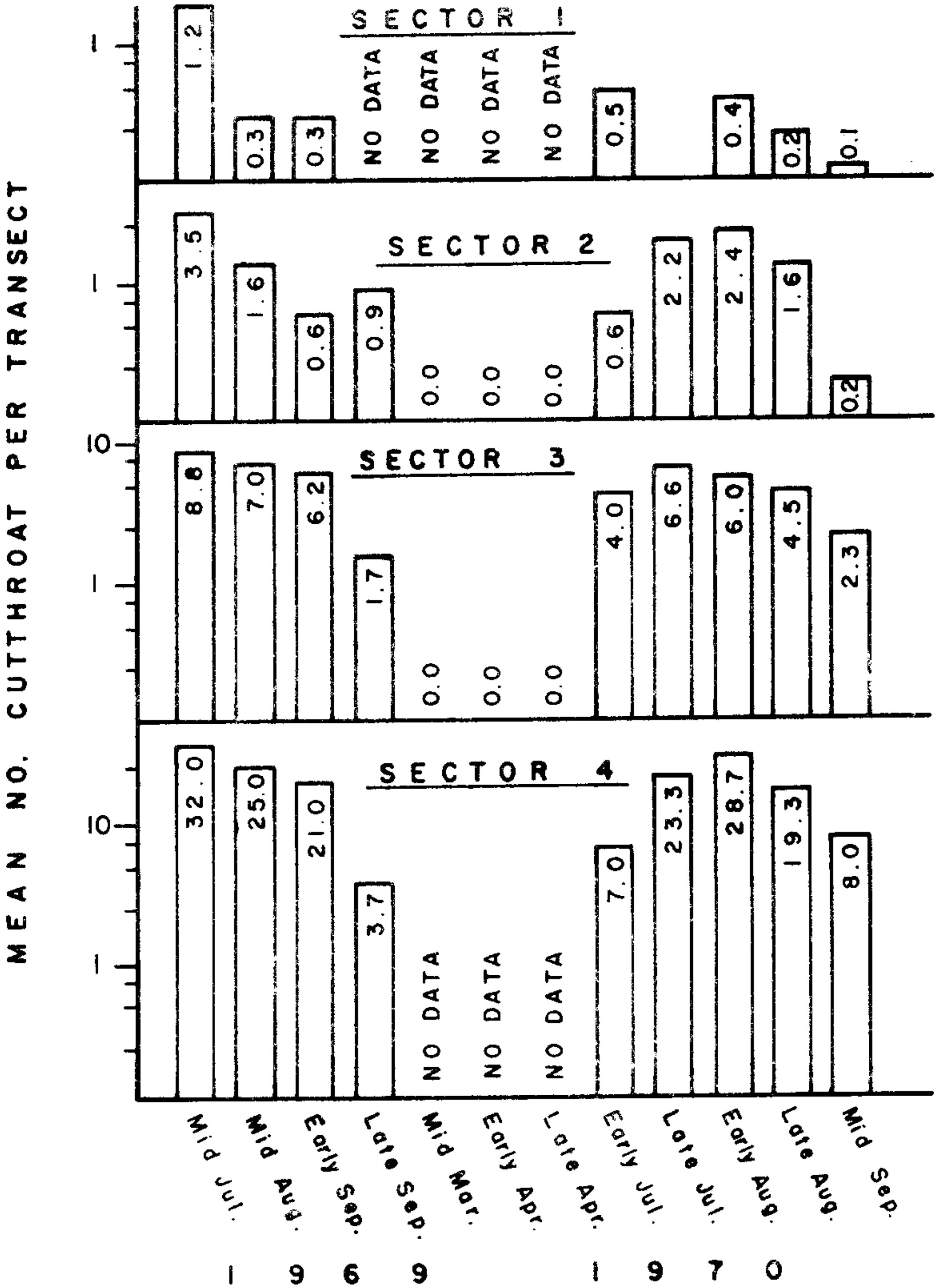


Figure 5. Counts of cutthroat trout in snorkeling transects of the St. Joe River in 1969 and 1970.

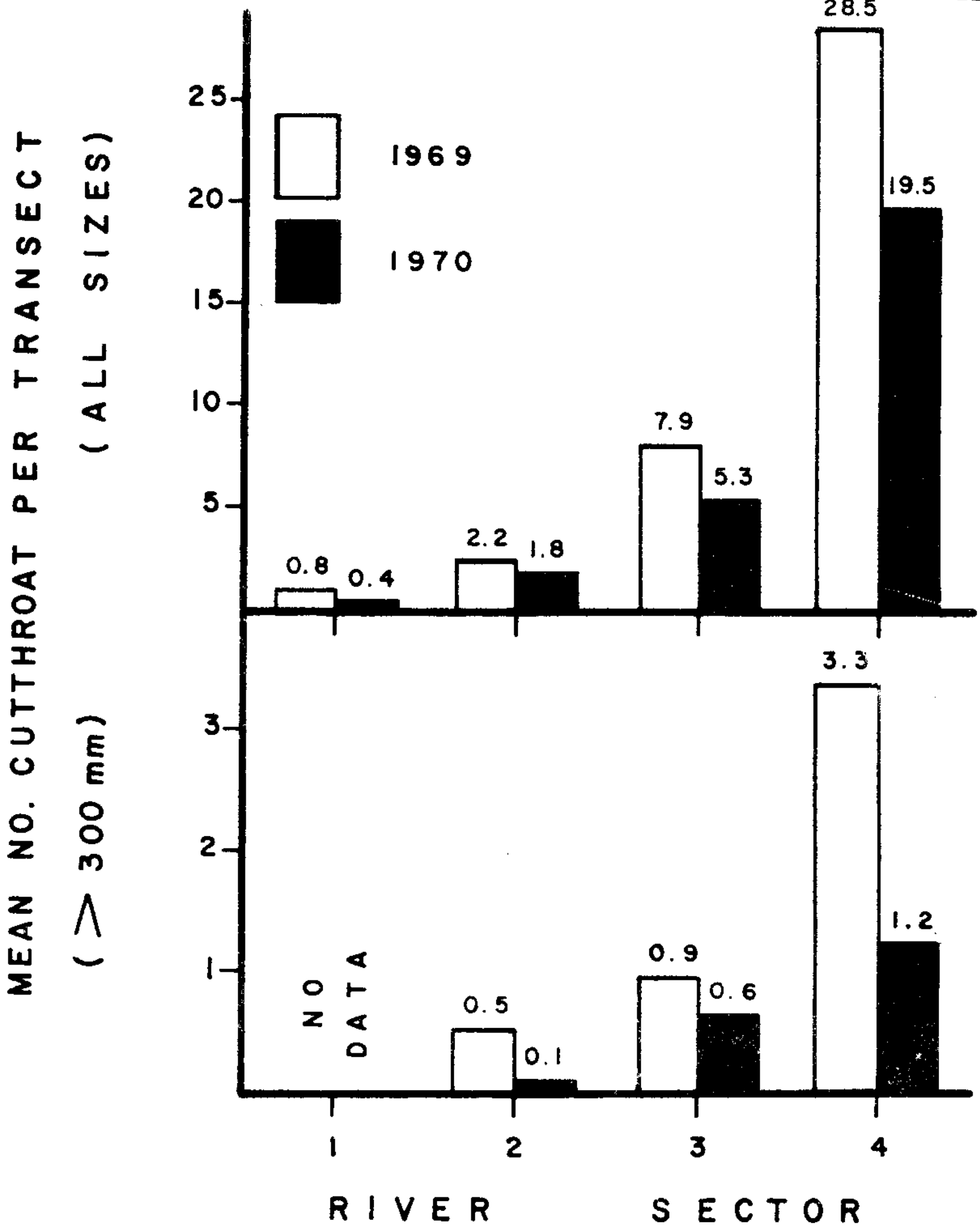


Figure 6. Mean number of cutthroat trout per transect, counted in the St. Joe River during July and August, 1969 and 1970.

at the bottom of deep pools prior to spawning. They were less abundant in sectr one than in sectors above Avery (Figure 7). Jeppson (1959), Sigler (1951) and Rawson and Elsey (1950) stated that mountain white-fish comprised a majority of fish biomass in many lakes and rivers of the West.

On several occasions I witnessed large schools of whitefish gorging themselves on the drift while a number of smaller cutthroat lingered behind snatching up the remains. Godfrey (1955) and Laakso (1951) reported that trout and whitefish have similar food habits and therefore may compete for food. Hayden (1967) observed an in-verse relationship between large numbers of whitefish and cutthroat in Fish Creek, Wyoming, and suggested that the two species may have competed for space.

Squawfish apparently moved from sector one (where they were most numerous) to sector two during late July and August when water temperatures were peaking. None was observed in sectors three and four (Figure 8). Because squawfish compete with and prey on trout (Brett and McConnell, 1950; Thompson, 1959), MacPhee and Ruelle (1969) developed a selective toxicant which kills squawfish without harming trout. The use of this piscicide (1, 1' - methylenedi-2-naphthol r "squoxin") in recent years on the St. Joe, has reduced squawfish numbers. Application of squoxin in July, 1970, probably caused the reduction in numbers observed between 1969 and 1970 (Figure 8). Angling methods

Possibly because anglers had their best success with bait, somewhat less success with flies, and relatively poor luck with

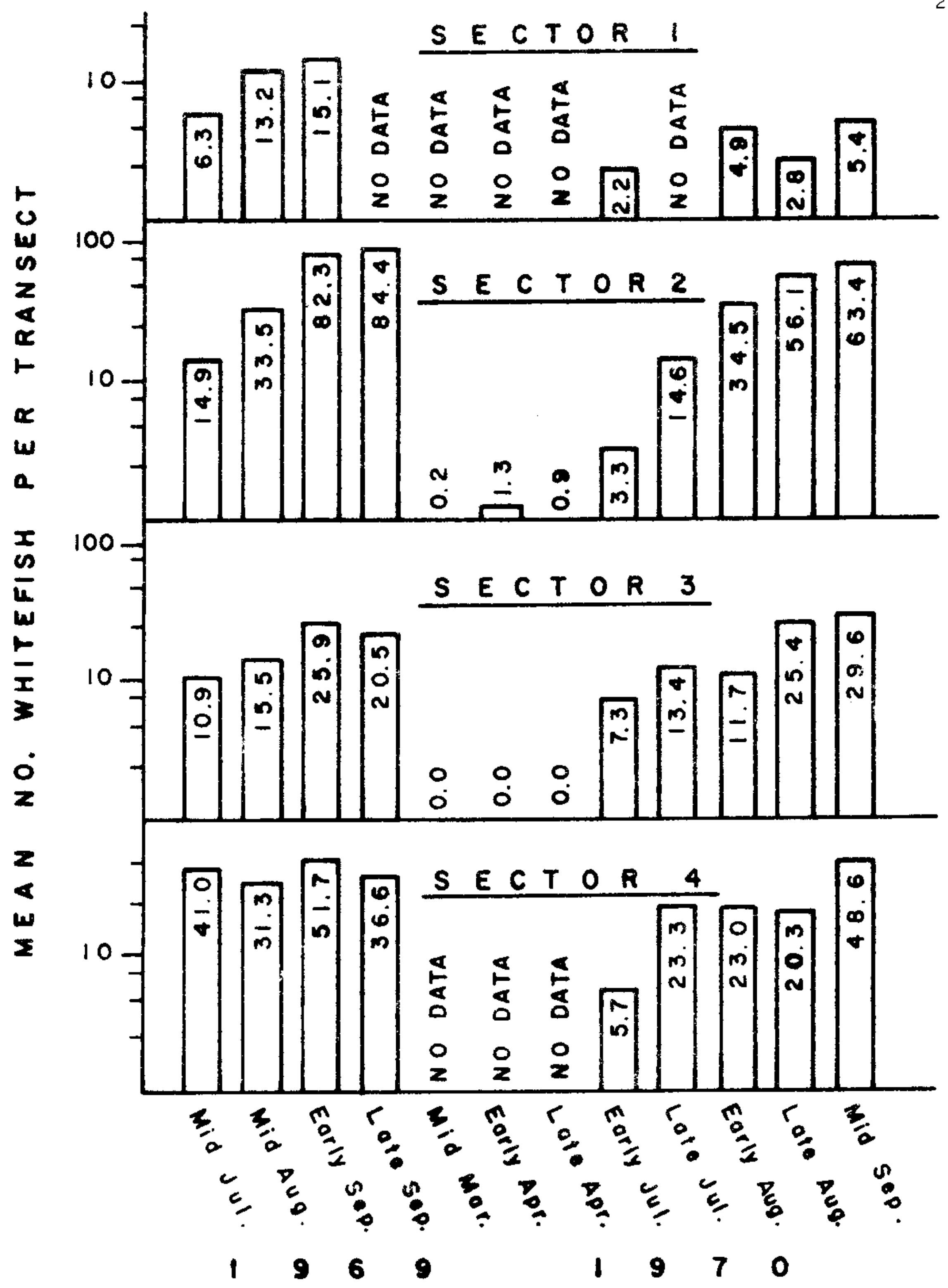


Figure 7. Counts of whitefish in snorkeling transects of the St. Joe River in 1969 and 1970.

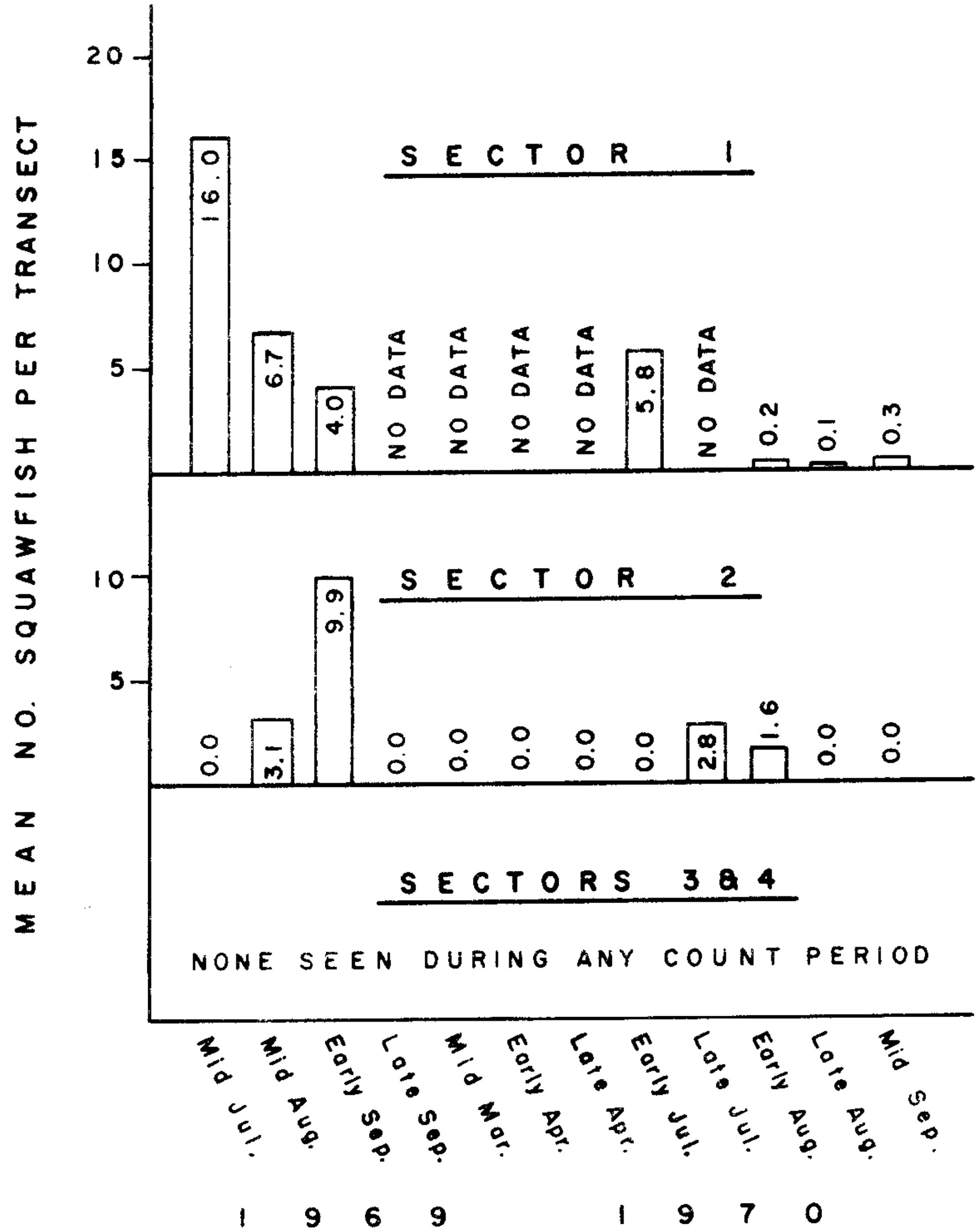


Figure 8. Counts of squawfish in snorkeling transects of the St. Joe River in 1969 and 1970.

lures (Figure 9), most fished with bait, somewhat fewer preferred flies, and comparatively few used lures on the St. Joe (Figure 10). Dunn (1968) found that most anglers used either flies or salmon eggs on the St. Joe in 1968.

In his state-wide fishing survey, Gordon (1970) reported that 73%, 58% and 44% of Idaho anglers used bait, lures and flies, respectively, at least one-quarter of the time. More than twice as many anglers used bait as fished with lures or flies exclusively.

Species composition of catch

In sectors two and three (where the Idaho Fish and Game Department annually stocked rainbow trout), cutthroat trout comprised 33-40%, rainbow trout made up 49-56%, and rainbow x cutthroat hybrids constituted 8-10% of the catch in 1968 through 1970. In sector four, cutthroat made up more than 90% of the catch (Table 11).

Catch rates of cutthroat

Anglers caught more cutthroat per hour in upper than in lower river sectors and in 1969 versus 1970 (Figure 11). Catch rates in sector four (roadless area) were twice those in sector three, and up to 25 times those in sector one. In 722 angler-hours in 1969 and 1586 in 1970, fishermen caught 0.7 and 0.62 cutthroat per hour respectively, from the whole river. In 1968, Dunn found that catch rates ranged from about 0.1 cutthroat per hour in sector one to 0.4 cut-throat per hour in sector three.

Bilton and Shepard (1955) reported that the catch rate of cutthroat trout averaged 0.94 fish per hour from the Lakelse River and 1.14 fish per hour from Lakelse Lake, British Columbia, during

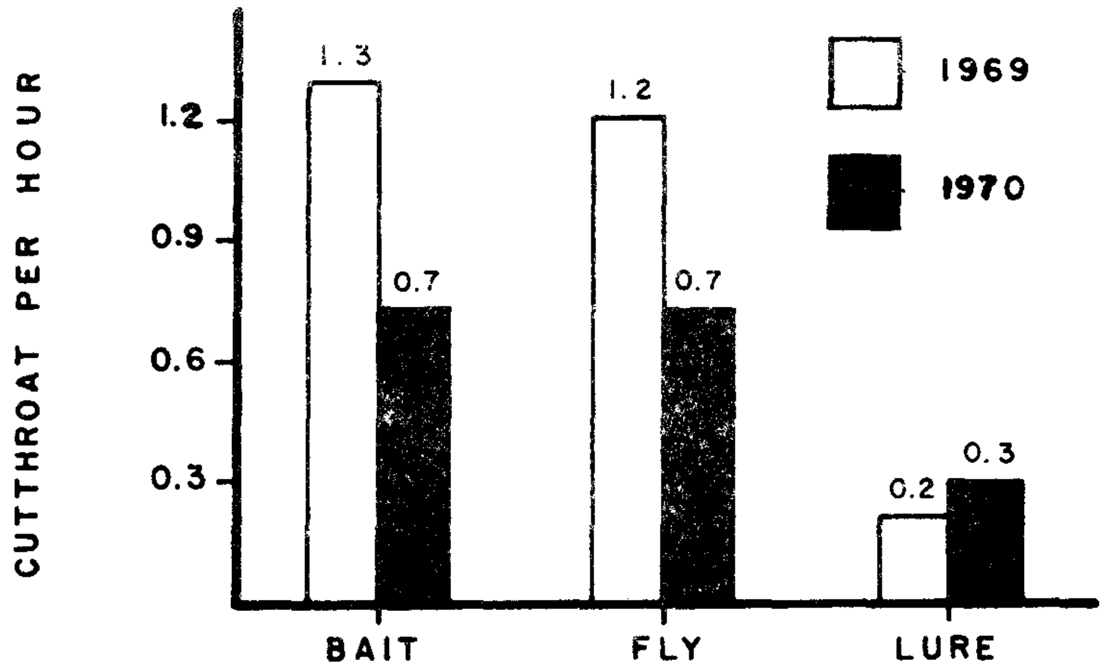


Figure 9. Catch rates of cutthroat trout, by method, on the St. Joe River in 1969 and 1970.

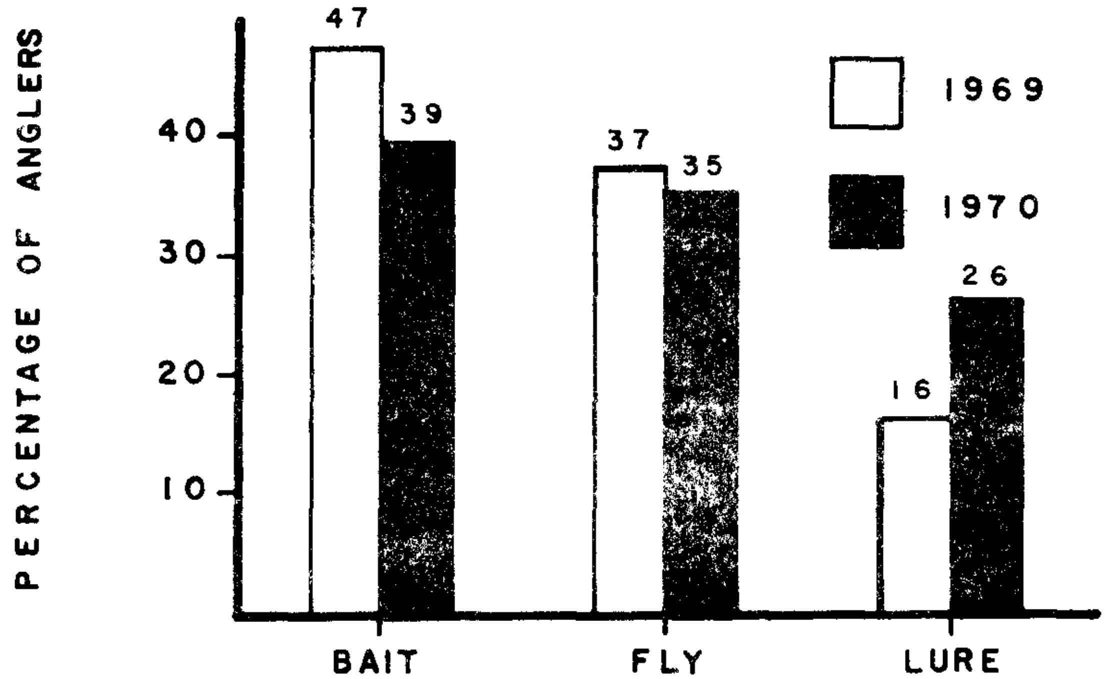


Figure 10. Percentages of anglers who used bait, flies and lures on the St. Joe River in 1969 and 1970.

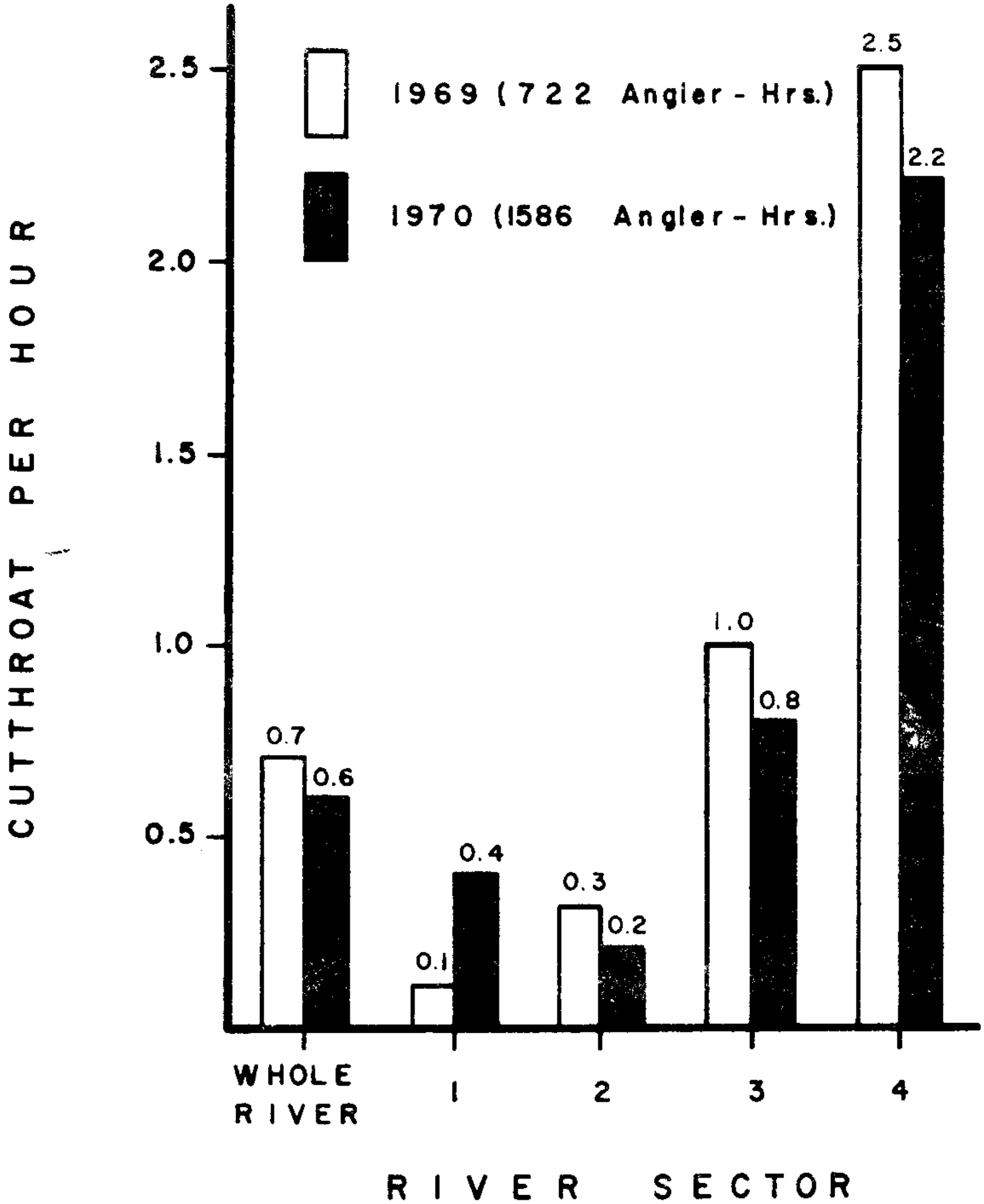


Figure 11. Catch rates of cutthroat trout from the four study sectors of the St. Joe River in 1969 and 1970.

Table 11. Species composition of catch from St. Joe River (above Avery) in 1968 through 1970.

Species	River sector	Year: 1968 1/	1969 2/	1970 2/
Cutthroat	2&3	2866(35) 3/	413(40)	854(33)
	4	No data	91(91)	260(96)
Rainbow	2&3	4136(51)	506(49)	1446(56)
	4	No data	2(2)	3(1)
Rainbow x cutthroat hybrids	2&3	658(8)	93(9)	257(10)
	4	No data	7(7)	8(3)
Whitefish, Squawfish & Dolly varden	2&3	526(6)	21(2)	19(1)
	4	No data	0	0

1/ Estimated total catch from Dunn (1968).

2/ Inspected catches.

3/ Numbers in parentheses are percentages from designated sectors and years.

1950-1954. Mallet (1961) noted that the catch rate of cutthroat on the Middle Fork of the Salmon River ranged from 0.36 per hour in October, 1959, to 1.19 per hour in June, 1960. Ortmann (1969) found that anglers on float trips caught 0.52 cutthroat per hour from the same river in the summer of 1968.

Length compositions of cutthroat harvest

In 1968, 1969 and 1970, cutthroat harvested from sectors two and three of the St. Joe River had modal lengths of about 225 mm,

175 mm and 165 mm respectively (Figure 12). The percentage of captured fish which measured 230 mm (TL) or more, declined from 46% in 1968 to 10% in 1970; and the percentage which measured 270 mm or more, dwindled

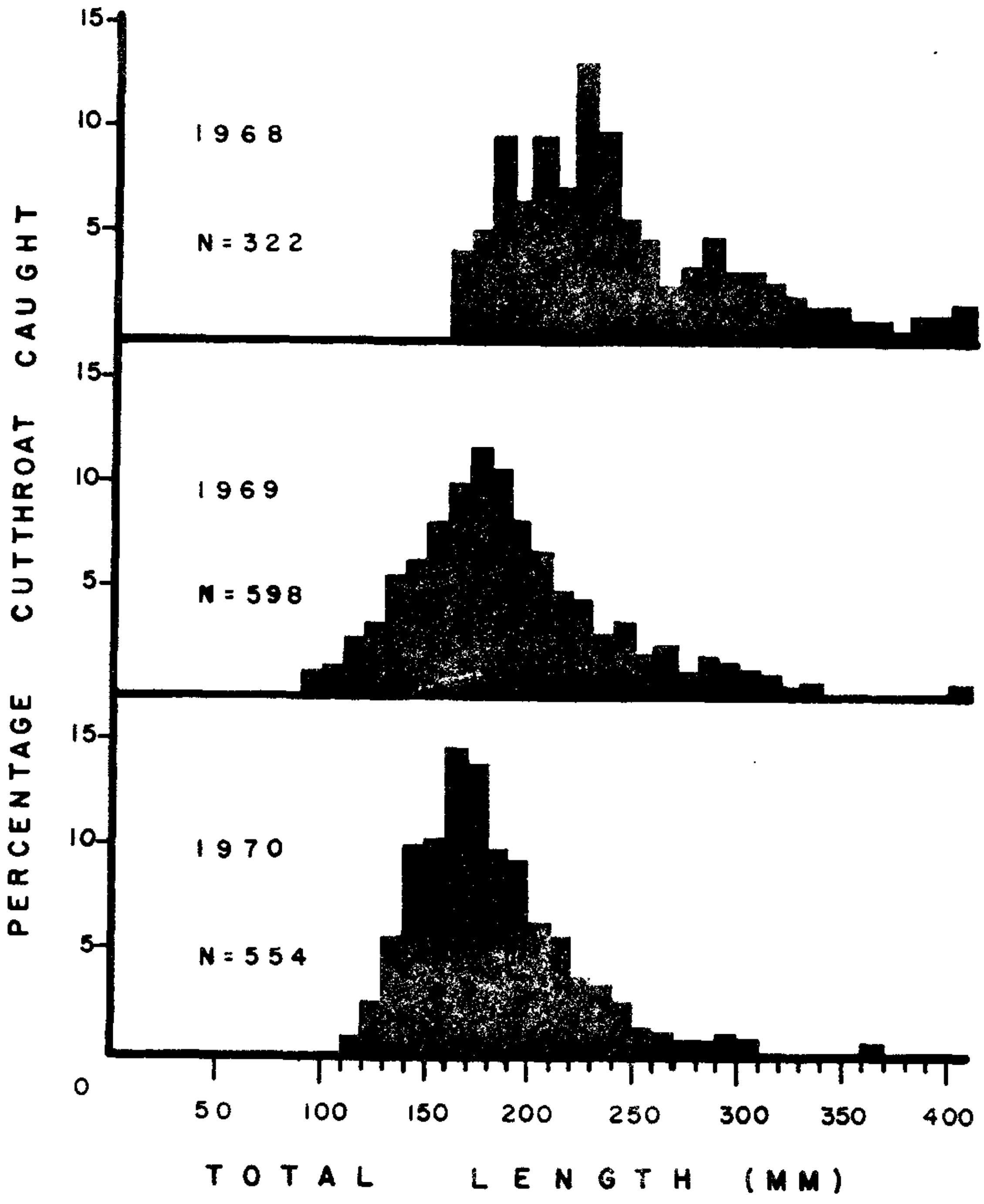


Figure 12. Length-frequencies of cutthroat trout caught from sectors two and three (combined) of the St. Joe River in 1968, 1969 and 1970.

from 25% in 1968 to only 2% in 1970.

Cutthroat caught from sector four during 1969 and 1970 averaged larger than those harvested from sections two and three combined, al-though ranges were similar (Figure 13). Of cutthroat inspected from sector four, 24% and 13% measured at least 230 mm and 270 mm, respectively, but only 13% and 5% of the fish from sections two and three had similar lengths.

During 1969 and 1970, project personnel caught and measured fish in several tributaries and in the main river to establish a base for comparison in future years. Our catch from the river (above Avery) averaged smaller than fish examined in angler creels (possibly because we used flies almost exclusively), but larger than our catch from side-streams (Figure 14).

Age-growth of cutthroat

Referring to the guidelines in Ricker (1968), Lagler (1956) and Bennet (1967), regarding annuli identification, and using the calculated body-scale regression equation, I aged 347 cutthroat trout, back-calculated lengths at each annulus, and computed annual increments of growth (Table 12). During the first two years in the river, the average fish grew about 50 mm a year. Thereafter, the rate of growth decelerated as the fish neared the end of its life span (six years). I observed two exceptionally large cutthroat (greater than 400 mm) near Gold Creek, and suspect that these fish were adfluvials.

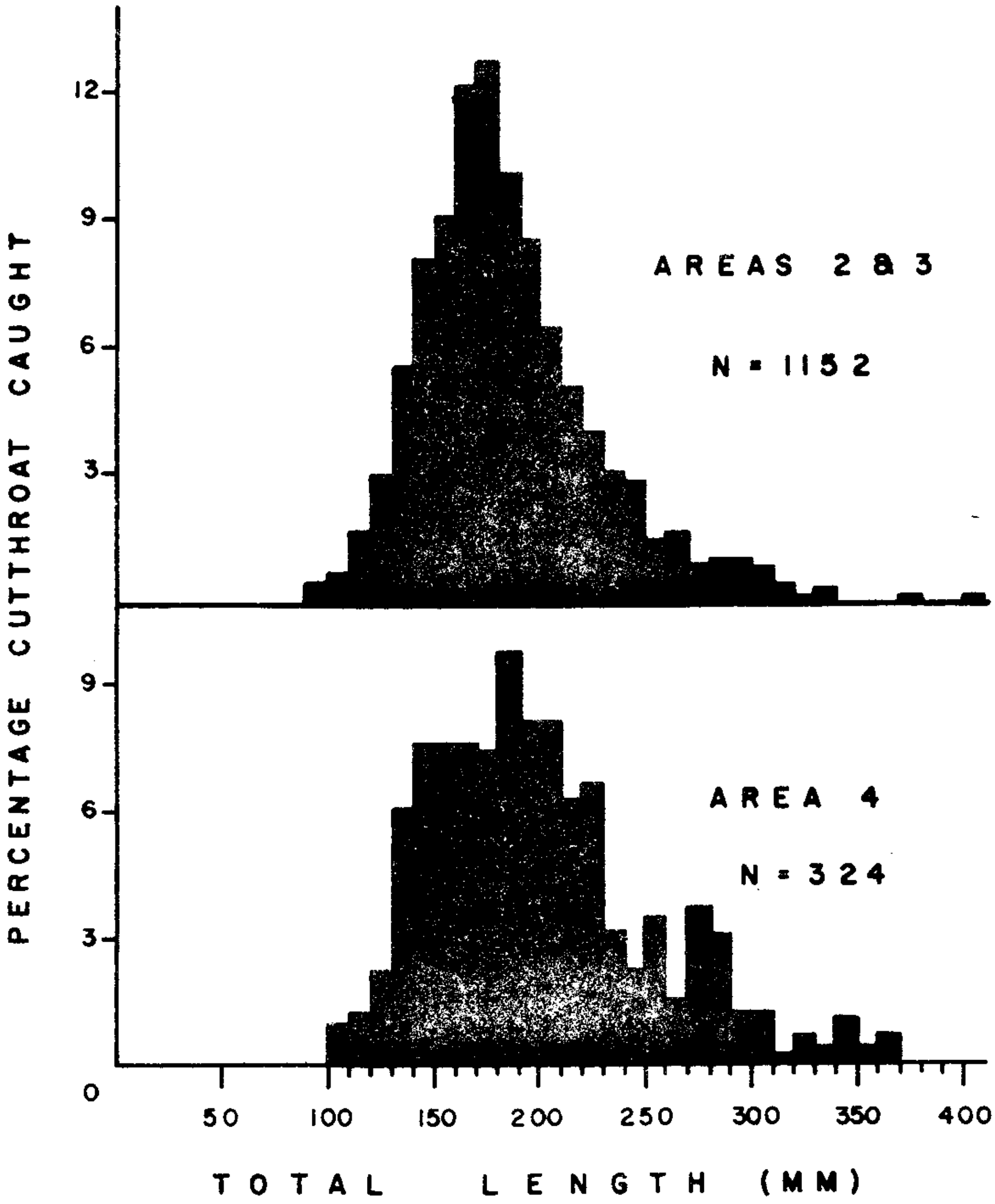


Figure 13. Length-frequencies of cutthroat trout caught from areas two and three (combined) and area four of the St. Joe River in 1969 and 1970.

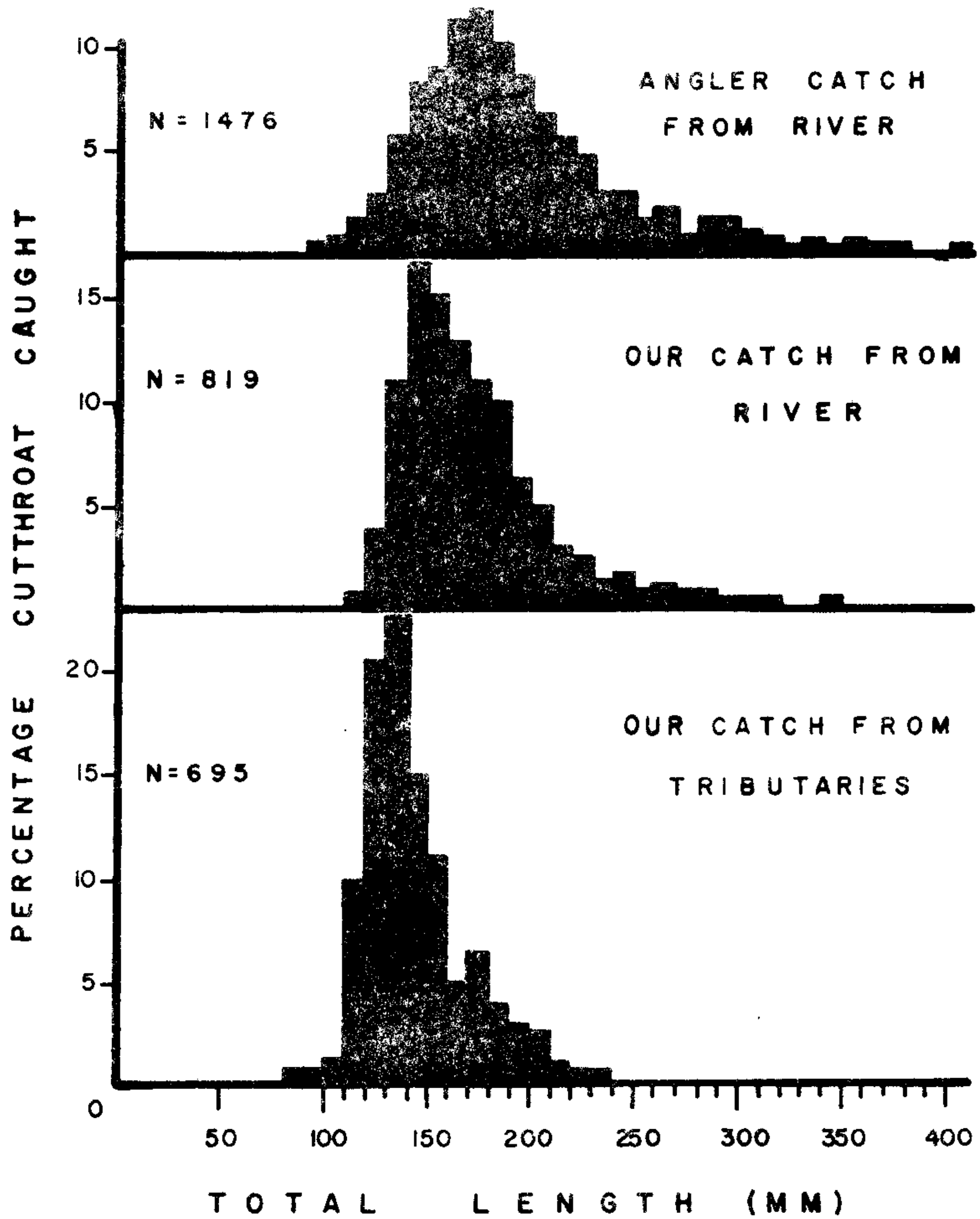


Figure 14. Length-frequencies of cutthroat trout caught by the angling public (from main river) and by project personnel (from main river and tributaries) from all sectors (combined) of the St. Joe River in 1969 and 1970.

Table 12. Calculated total lengths and annual increments of growth for cutthroat trout collected in 1969 and 1970 from the St. Joe River.

Age class	No. fish	Mean TL at capture (mm)	Computed mean length at each annulus (mm)					
			1	2	3	4	5	6
I	29	78	53					
II	27	119	58	94				
III	127	187	52	93	147			
IV	124	226	50	89	138	191		
V	32	285	51	91	144	196	240	
VI	8	353	--	91	150	206	254	291
Weighted mean length . . .			52	91	143	192	243	291
Increment of growth. . . .			52	40	52	52	45	36
Number of fish			140	318	291	164	40	8

Probably because of the shorter growing seasons, cutthroat grew more slowly in the St. Joe River than in other western streams (Table 13).

Table 13. Back-calculated total lengths of cutthroat trout from several western streams (taken from Carlander, 1969).

Stream	No.	Computed TL at each annulus (mm)					
		I	II	III	IV	V	VI
Sand Cr., Ore. (Sumner, 1962)	376	69	112	173	211	249	251
Mont. streams (Peters, 1964)	2323	74	132	198	279	330	302
Logan R., Utah (Fleener, 1952)	234	99	170	231	-	-	-
Thompson R., Mont. (Echo, 1955)	41	130	198	262	318	-	-
W. Gallatin R., Mont. (Purkett, 1951)	91	104	175	257	274	-	-
St. Joe R., Ida. (Averett, 1962)							
upper tributaries	118	53	102	152	224	-	-
lower tributaries	195	71	135	226	292	-	-

Forty percent (140) of the 347 cutthroat aged frmed an annulus after the first growing season (these fish probably grew faster and/or emerged earlier than those which didn't form similar annuli), and these fish averaged about 52 mm at that time. Laakso and Cope (1956) found that 31.5% of the cutthroat examined from tributaries of Yellow-stone Lake formed an annulus at the end of the first growing season.

By observing the width of and spacing between circuli and annuli, I found that most cutthroat migrated from tributaries near the end of their third growing season at a TL of 120-140 mm. Of

166 cutthroat checked, 68% (112) had three years, 17% (28) two years and 5% (9) had four years of tributary growth. Ten percent appeared to have emerged in the main river.

Maturity and spawning of cutthroat

Most males and females matured at age classes TV and V, respectively. Of 89 males examined, none had matured at lengths less than 177 mm, but all *which* measured at least 213 mm, had reached maturity. In contrast, none of the 92 females inspected had matured at lengths less than 174 mm, but all fish over 262 mm had reached maturity (Table 14). Mallet (1961) found most cutthroat matured at age class V, at a fork length of 300 mm. Mallet and I obtained our data from cutthroat taken in the main stems of the respective rivers. Cutthroat in smaller tributaries often mature at much shrter lengths (Bjornn, 1957; Averett, 1963).

Table 14. Maturity of cutthroat trout at various total lengths as assessed by gonadal inspection.

	TL(mm)	Number inspected	Number mature	Percent mature
MALES	147-176	32	0	0
	177-194	12	6	50
	195-212	16	10	63
	212+	29	29	100
FEMALES	141-173	20	0	0
	174-196	16	4	25
	197-218	17	5	29
	219-240	20	8	40
	241-262	11	6	55
	262+	8	8	100

I suspect that most cutthroat spawned in tributaries, just be-fore and/or during the high water period of May and June, because I observed no spawning activity either before or after this period. Unfrtunately, dirty water obscured my view during high runoff. Averett (1963) found that most cutthroat spawned during April and May in the lower tributaries of the St. Joe River. A scarcity of suitable spawning gravel in the river probably limits main stem spawning.

Cutthroat may spawn in consecutive or alternative years (Ball and Cope, 1961; Hayden, 1967; Snyder and Tanner, 1960; Calhoun, 1944). Though I could not determine which prevailed in the St. Joe River, gonadal examination indicated that some fish spawned more than once. Age structure and mortality of cutthroat populations

Assuming that the age compositions of the catches (calculated by applying conversion lengths in Table 5 to the length-frequencies in Figures 12 and 13), reflected age frequencies of their respective populations, I can state that cutthroat had higher mortality rates in sectors two and three (heavily-fished) than in sector four (lightly-fished), and increasing mortality rates in all sections since 1968 (Table 15). Mallet (1961) computed an annual survival rate (s) of 0.303 for cutthroat from the Middle Fork of the Salmon River during 1959-1960. Eight years later on the same stream, Ortmann (1969) compiled an age-frequency from which I computed an (s) of 0.233.

The percentage of mature female cutthroat caught by anglers from sectrs two and three of the St. Joe River declined from 13% in 1968 to 2% in 1970; and the percentage caught from sector four declined from 12% in 1969 to 7% in 1970. Applying the same calculations to Mallet's (1961) and Ortmann's (1969) data, I computed that the percentage of mature females in the catch decreased from 4% in 1959-1960 to 1% in 1968.

Cutthroat populations in tributaries

The opening of Red Ives Creek to fishing in 1970 provided an opprtunity to observe the effects of fishing on size and abundance of cutthroat populations in tributary streams. Between 1969 and 1970, the abundance and catch rate of cutthroat in a one-quarter mile stretch of this stream declined 59% and 43% respectively (Table 16), and larger cutthroat (greater than 200 mm) virtually disappeared (Figure 15). I observed two to seven times more cutthroat per 100 yds in Red Ives Creek than in other streams surveyed by snorkeling; and I caught up to 2.7 times more cutthroat-per-hour from Red Ives Creek than from other streams (Table 16).

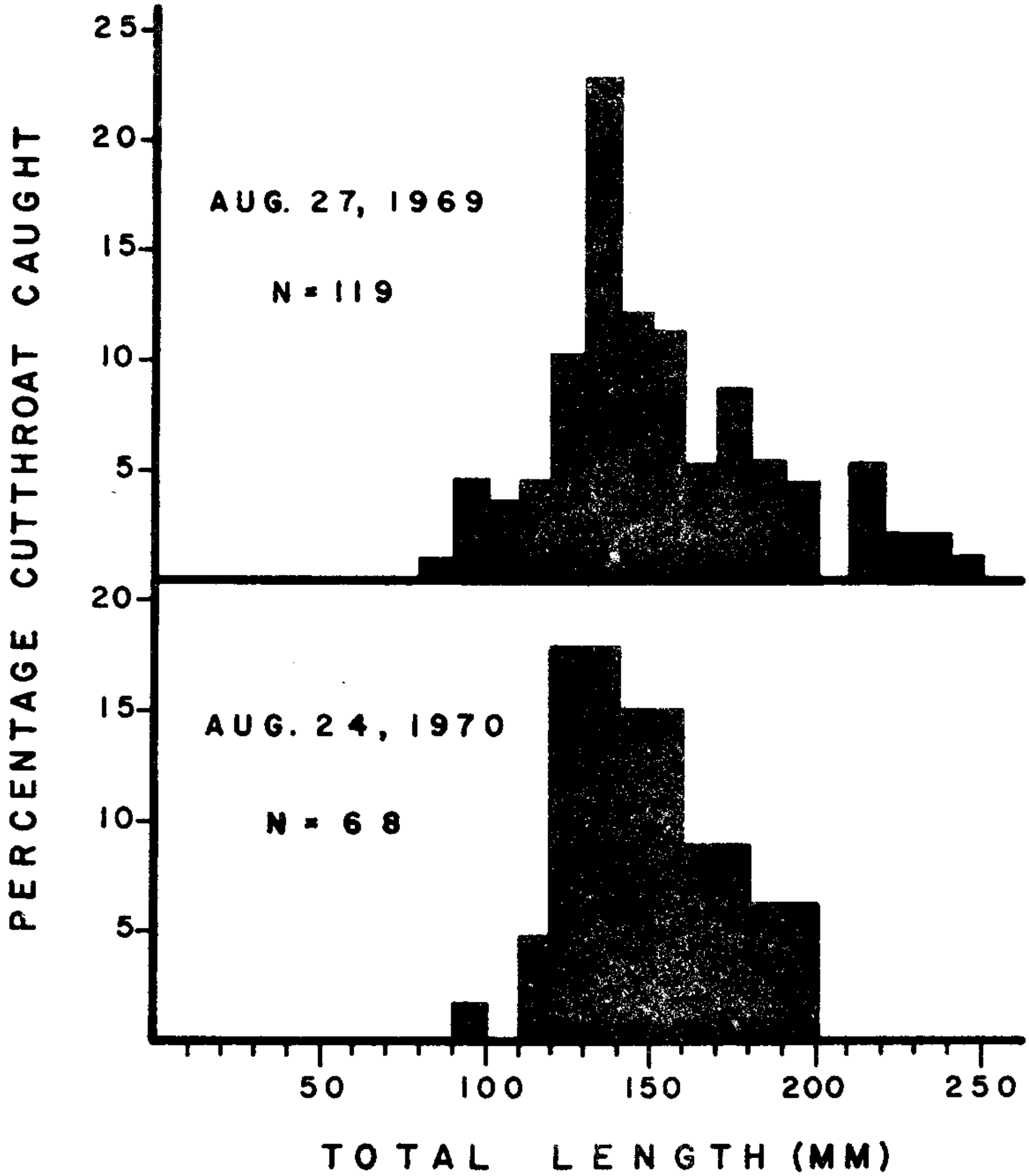


Figure 15. Length-frequencies of cutthroat trout caught from Red Ives Creek in 1969 and in 1970.

Table 15. Age compositions, instantaneous mortality rates and annual survival rates of cutthroat trout in lightly and heavily-fished sections of the St. Joe River in 1968, 1969 and 1970.

Sector	Year	Age class I	II	III	IV	V	VI	Instantaneous mortality rate (i)	Annual survival rate (s)
2&3	1968 2/	0	0	85(30)	120(43)	49(18)	26(9)	0.765	0.465
	1969	0	75(17)	231(54)	86(20)	35(8)	5(1)	1.277	0.279
	1970	0	47(12)	254(65)	76(19)	13(3)	1(1)	1.846	0.158
4	1969	0	15(17)	1/ 34(39)	17(20)	15(17)	6(7)	0.578	0.561
	1970	0	17(13)	64(47)	35(26)	16(12)	3(2)	1.020	0.361

1/ First value represents number of fish; value in parentheses equals the corresponding percentage.

2/ 1968 values computed from Dunn (1968).

Table 16. Abundance and catch rates of cutthroat trout in several tributaries of the St. Joe River.

Tributary and year	Cutthroat per 100 yds	Cutthroat per hour
Beaver Cr. (1970)	5	11.5 (8) 1/
Simmons Cr. (1970)	6	7.4 (5)
Gold Cr. (1970)	15	16.1 (16)
Copper Cr. (1970)	-	15.0 (6)
Red Ives Cr. (1969)	37	19.8 (6)
Red Ives Cr. (1970)	15	11.3 (6)

1/ Angler-hours in parentheses.

Angler opinion survey

Many anglers who fished the St. Joe River preferred to catch native cutthroat trout rather than planted rainbow trout, felt that the quality of fishing had deteriorated in recent years, and would accept severe angling restrictions to save the cutthroat. Specific questions posed to anglers and corresponding responses appear below.

1. Question: Do you prefer to catch native cutthroat trout or hatchery-reared rainbow trout?

   Response: Of 188 respondents below *Avery,* 39% indicated a definite preference for cutthroat. Of 223 respondents above Avery, 57% preferred to catch cutthroat. The remainder indicated no preference for either of the two species.

2. Question: Do you feel the quality of fishing on the St. Joe River has improved, deteriorated or remained unchanged in recent years?

   Response: Of 143 respondents who preferred to catch cut-throat, 40% said fishing quality had deteriorated, 51% thought it was about the same and only 9% said it had improved.

3. Question: Do you have any suggestions on how we could improve the fishing on the St. Joe River?

> Response: Of 107 respondent , 59% indicated that we must reduce or inhibit angling pressure and/or public access
> to improve fishing. Nine percent thought we should poison squawfish, and others said we should close tributaries or impose various types of angling restrictions.

I explained that data collected prior to July, 1970 (when I began assessing angler attitudes), indicated that anglers were overfishing the fluvial cutthroat stock. I outlined the recent history of declining cutthroat stocks, and suggested that cutthroat populations may not remain viable for many more years in the St. Joe River. Finally, I described two general managerial alternatives which we could employ, and asked them to choose the one they preferred.

4. Alternative 1: Continue the present management policy on the St. Joe River. This includes a daily bag limit of 15 fish, no size limit and stocking hatchery-reared rainbow trout to supplement and eventually replace the harvest of cutthroat trout.

   Alternative 2: Change the present management policy on the St. Joe River to severely restrict the harvest of cutthroat in an effort to perpetuate the stock. This would involve some type of "quality fishery" (catch and release, trophy fish, etc.), or a partial closure of the river.

   Response: Of 292 respondents, 88% chose alternative 2. At the .05 level of significance, 84 to 92% of anglers who fished the St. Joe River would accept a drastically reduced harvest to save the cutthroat. Of 45 respondents who fished at least 10 days a year (local residents), 87% chose alternative 2.

Cooper (1959), McFadden (1969) and Gordon (1970) stressed the importance of considering angler attitudes when frmulating management policy. Because anglers who fish the St. Joe River want to preserve the cutthroat population rather than replace it with hatchery-reared fish, we can best conform to angler desires by imposing restrictive regulations on the cutthroat fishery.

DISCUSSION

After preliminary data analysis we concluded that the cutthroat stock in the St. Joe River was over-exploited, people wanted it pre-served and thus we had to reduce mrtality. We presented our data to the Idaho Fish and Game Department and they revised angling regulations to include a trophy-fish program on the upper half of the river (above Prospector Creek). Beginning in May, 1971, anglers may keep three, large (at least 13 inches) fish a day from this section. Below Prospector Creek, regulations will not change (daily bag limit of 15 fish; no size limits).

Evidence of over-exploitation

Cutthroat abundance, size, annual survival rate and proportion of mature females have declined in recent years. These data illustrate an unhealthy and declining population (Ricker, 1968; Bennet, 1967;. Considering the recent history of declining cutthroat stocks, it seems likely that the structure of cutthroat populations and the quality of the fishery in the St. Joe River have deteriorated to a point where economic, if not biological extinction is imminent. Bingham (1962) reprted that Greenback cutthroat (Salmo clarki stomias) and Colorado River cutthroat (Salmo clarki pleuriticus) have nearly vanished from Wyoming; Hagen (1958) felt that cutthroat may not survive long in Colorado, Idaho, Utah and Wyoming; Sigler and Miller (1963) claimed that Utah cutthroat (Salmo clarki utah) had become virtually extinct in Utah; Carlander (1969) reported the disappearance of many subspecies of cutthroat from western waters; Miller and Alcorn (1954) reported that cutthroat were vanishing from Nevada, and Cope (1956) felt that cutthroat had a bleak future in Utah. Miller (1957), Hauck (1959), Bjrnn (1957), Neave (1949) and others have recorded the plight of the cut-throat.

Comparisons of abundance, catch rates, length and age compositions of the harvest, annual mortality rates and percentages of mature females from heavily and lightly-fished sectors revealed that cutthroat in sector four (roadless sectr) had a much healthier population structure. Cutthroat trout in Red Ives Creek also had a healthier population structure in 1969 (when closed to fishing) than

in 1970 (when open to anglers). In view of recent increases in fishing pressure, the extraordinary vulnerability of cutthroat trout, population dynamics of the species, and reports relating over-fishing and declining cutthroat stocks (Drummond, 1966; Hauck, 1959 i.e.), I concluded that over- fishing caused the recent deterioration of the cut-throat trout fishery on the St. Joe River.

Cutthroat may be more vulnerable than any other trout or char. Shetter and Alexander (1965) found brook trout much easier to catch than brown trout and MacPhee (1966) found cutthroat about twice as susceptible as brook trout. Of all creel-sized cutthroat in a 2.4-mile stream section, MacPhee caught 50 percent (69) of them in 32 angling-hours. While fishing we tagged and recovered 11 cutthroat

on the same day. In addition, cutthroat appeared to feed very opportunistically. Novices could catch them with various fly patterns, even during specific insect hatches.

When populations experience heavy exploitation, compensatory mechanisms normally function to accelerate growth, advance maturity and increase fecundity (Kormondy, 1969; Andrewartha and Birch, 1954). Under extreme exploitation, however, compensatry mechanisms may not have time to operate (Cole, 1954). Considering various components (fecundity, longevity, age at first reproduction i.e.) which determine a species' innate capacity to increase, I can state that cutthroat (notably mountain stream stocks) have relatively low reproductive capacities when compared to other salmonids. This low capability implies non-resilient stock-recruitment relationships, unproductive yield functions, and an inherently low capacity for compensation. Because of their low reproductive potential and non-resilience, cut-throat trout in the St. Joe River probably have not had time, nor have the capacity, to compensate for large population losses.

Hybridization with rainbow trout has caused declines of many cutthroat stocks and subspecies (Miller and Alcorn, 1946; Hagen, 1958; Miller, 1957; Sigler and Miller, 1963; Carlander, 1969 and Cope, 1956). Conversely, planted trout may benefit native stocks by buffering fishing pressure (Chamberlain, 1943). Despite low wintering survival of planted rainbow, some hybridization occurred in the St. Joe River (the *high* degree of sterility I observed in rainbow x cutthroat hybirds probably restrained appearance of F_2 individuals). Though introgression could alter the native gene pool and lead to the eventual fall of the cutthroat stock, I fail to see how it could have caused the reductions observed since 1968.

Though habitat destruction may have contributed to the deterioration of cutthroat trout in the St. Joe River, it seems unlikely that it could have caused the recent reductions. Between 1933 and

1938, the Civilian Conservation Corps constructed the existing road along the river from Falls to Red Ives Creeks. In the process, they denuded miles of streambank and probably upset cutthroat populations. In recent years, however, little habitat destruction has occurred in the area.

Successive poor year-classes in 1964 and 1965 could have brought about the population structure observed in 1969 and 1970. Bulkley and Benson correlated mean water levels, used as an index of stream flow, (r=-0.955) and mean water levels with water level fluctuations during spawning (R=0.978) with year class strength. A review of U. S. Geological Service flow records disclosed near-normal flows in the drainage during the years in question. The substantial number of large fish in Dunn's (1968) length-frequency data also contradict this hypothesis.

It seemed likely, therefore, that over-fishing posed the most serious threat to the future of cutthroat trout in the St. Joe River. In view of the recent history of cutthroat stocks, and taking into account their vulnerability, population dynamics and the findings re-ported in this and other papers, I could not consider cutthroat survival compatible with current, liberal angling regulations. The old cliche - you can't have your cake and eat it too - never seemed more apropos. Social and philosophical aspects of management

Before discussing alternative management programs fr the St. Joe River, I should redefine the problem in its social sense, and summarize the philosophy which guided formulation of the new management program. Because most anglers were willing to forfeit possession limits or accept reduced daily bag limits to save the cutthroat, rather than gradually have cutthroat replaced with *hatchery*-reared rainbow trout, a managerial problem existed. Many other anglers, however, were reluctant to relinquish previous possession limits to save the cutthroat.

Because all citizens of Idaho own the resource, fishery management personnel should strive to please all segments of the population. To best accomplish this (either on the St. Joe River or on a regional or state-wide basis), we should abandon the outdated concept of maximizing sustained physical yield, and think in terms of maximizing human satisfaction. Simply stated, this involves optimizing the combination of "put and take" and "quality fisheries" (catch-release, trophy-fish etc.) to maximize satisfaction of all types of anglers (meat fishermen; anglers looking for a "quality experience" etc.), and preserving gene pools of native stocks to maximize future options. Though no state has accepted this philosophy on a regional scale, many have instituted localized programs. Accrding to Teague (1968), 31 states, including Idaho, had some type of quality fishing program; twenty-three planned to expand existing programs; none planned to discontinue them, and six states without such programs, planned to initiate them.

<u>Maximizing satisfaction on the St. Joe River</u>

To maximize satisfaction on the St. Joe River, we established a program which attempts to optimize the combination of meat harvest, "quality fishing" and preservation of the native gene pool. By dividing the river into two managerial sections we can manage the lower section (which contained few cutthroat) to maximize meat harvest (put and take fishery), and the upper section to enhance cutthroat populations by reducing mortality. In deciding where to divide the river, we considered river habitat (pool-riffle structure, wintering areas, spawning grounds i.e.), existing fish populations, proportions of anglers (and estimated proportions of future anglers) who preferred meat and recreational fishing, river accessibility (roads, campgrounds i.e.) and scenic values of the environment. Prospector Creek (Figure 2) was chosen as the dividing line.

Having established boundaries, we next considered suitable regulations for each section. To maximize meat harvest from the lower section, only a daily bag limit seemed warranted. To reduce mortality in the upper section, we could have closed it to fishing or instituted some type of restrictive regulations. Because we felt that the St. Joe River stock could endure the hooking mortality inherent in a "quality fishing" program, we chose the latter course.

To reduce mortality, we could have restricted the number of harvestable fish from none (catch-release) to a few large fish (trophy-fish fishery). By adjusting minimum size and daily bag limits, we should achieve the same results with the trophy-fish program as we would have with catch-release regulations. By allowing anglers to keep an occasional lunker-sized fish, however, we should increase angler satisfaction. Managers have used size limits to assure an adequate number of breeding individuals or to promote the harvest of a desired kind (Allen, 1954). Hunt, Brynildson and McFadden (1962) stated that appropriate size limits can permit trout to substantially increase their reproductive potential in streams which contain few spawners but abundant spawning habitat. Because cutthroat in the St. Joe River probably have a low biotic potential and a non-resilient stock-recruitment function, we could justifiably employ minimum size limits to reduce mortality. By setting the limit at 13•inches, we insured that most cutthroat would have a chance to spawn before they died. Because a minority of anglers usually catch the majority of fish (McFadden, 1957; Cope, 1957), we supplemented the size limit with a daily bag limit of three fish to help redistribute the catch.

Anglers on the St. Joe River had their best success with bait. On several occasions, I observed experienced salmon egg fishermen clean out pools in a matter of minutes. These anglers also caught greater proportions of larger, mature fish. Many investigators (Hunsaker II, Marnell and Sharpe, 1970; Mason and Hunt, 1967; Marnell and Hunsaker II, 1970) found high hooking mortality associated with bait fishing. There-fore, we prohibited bait fishing on the upper St. Joe River to minimize hooking mortality.

Several anglers suggested that instead of dividing the river into two managerial sections, we should continue to stock rainbow in the upper section, and apply separate regulations to native cut-throat and planted rainbow along the entire river. This would work only if all anglers could distinguish between cutthroat and rain-bow, if resultant hybridization wouldn't lead to the eventual extinction of the native cutthroat stock, and if we prohibited bait fishing.

We contemplated liberalizing regulations on tributaries in the upper area to allow anglers to harvest the slow-growing resident stocks. By establishing a separate minimum size limit of 6 or 7 inches, we could have protected most cutthroat destined to migrate to the main river. Separate regulations for the main stem and tributaries, however, would probably confuse many anglers and give conservation officers nightmares trying to enforce them. Consequently, we decided to apply the trophy-fish regulations to the whole upper drainage.

I mentioned earlier that many cutthroat migrated downstream in fall (from upper to lower managerial section). While in the lower section, they exposed themselves to heavy harvest. Although relatively few anglers fished the St. Joe River in fall, we should periodically monitor the harvest. If cutthroat catch becomes excessive, we may wish to impose seasonal restrictions on the fishery.

To evaluate the effects of management changes on cutthroat populations and angler attitudes, I suggest we collect information on the abundance and population structure of cutthroat trout, and conduct a follow-up angler-opinion survey during the next few years.

Other management considerations

In addition to the basic program outlined above, several other aspects of the fishery warrant consideration. Habitat improvement (terrestrial and aquatic) could create badly needed cover in and along various stream sections. We could ameliorate the conseᑫuences of road construction by revegetating denuded streambank sections and by constructing current-directing devices to create a mre favorable pool-riffle structure.

As suggested earlier, whitefish may compete with cutthroat for food and space. Possibly because whitefish look somewhat like suckers and squawfish, few anglers fished for them on the St. Joe River. Most anglers don't appreciate the fine flavor of whitefish (McHugh, 1940), nor recognize its good sporting capabilities (Laakso, 1951; McHugh, 1940; Dill and Shapovalov, 1939). By infrming and educating the angling public regarding this resource, we would not only create a new fishery, but we may reduce possible competition with cutthroat.

Some anglers preferred stocking cutthroat to supplement the native stock, while others objected to the planting of any hatchery-reared fish in a "quality fishing" area. Unlike the rainbow, cut-throat have difficulty withstanding the handling and stress inherent in the rearing-stocking process (Miller, 1951). Miller (1953) reported that stream-reared cutthroat survived much better than pond-reared, when transplanted to streams. If we decide to stock cutthroat in the upper St. Joe River, we should consider the possibility of constructing a holding pond in this area (possible locations exist) and propagate the St. Joe River stock for use in the St. Joe and other river systems.

LITERATURE CITED

Allen, K. R. 1954. Factors affecting the efficiency of restrictive regulations in fisheries management. New Zealand J. Sci. and Tech., Section B 35: 498-529.

Andrewartha, H. G. and L. C. Birch. 1954. The distribution and abundance of animals. Univ. of Chicago Press, Chicago. 782 p.

Averett, Robert C. 1963. Studies of two races of cutthroat trout in northern Idaho. M. S. thesis, Univ. of Idaho. 67 p.

Ball, O. P. and O. B. Cope. 1961. Mortality studies on cutthroat trout in Yellowstone Lake. U. S. Fish and Wildl. Serv., Res. Rep. 55. 62 p.

Bennet, George W. 1967. Management of artificial lakes and ponds. Reinhold Publ. Corp. , N. Y. 283 p.

Bilton, T. H. and M. P. Shepard. 1955. The sports fishery for cut-throat trout at Lakelse Lake, British Columbia. Fish. Res. Bd. Can., Progress Rep. of the Pacific Coast Stations No. 104: 38-42.

Bingham, Darrell A. 1962. Study of the serology of native cut-throat trout. Wyoming Game and Fish Comm., Job Completion Rep., Proj. No. FW-3-R-9. 10 p.

Bjornn, T. C. 1957. A survey of the fishery resources of Priest and Upper Priest Lakes and their tributaries. Idaho Fish and Game Dep., Dingell-Johnson Completion Rep., Proj. F-24-R. 176 p.

1961. Harvest, age structure, and growth of game fish populations from Priest and Upper Priest Lakes. Trans. Amer. Fish. Soc. 90: 27-31.

_and Jerry Mallet. 1964. Movements of planted and wild trout in an Idaho river system. Trans. Amer. Fish. Soc. 93: 70-76.

Brett, J. R. and J. A. McConnell. 1950. Lakelse Lake sockeye survival. J. Fish. Res. Bd. Can. 8: 103-110.

Brown, C. J. D. and J. Bailey. 1952. Time and pattern of scale formation in Yellowstone cutthroat trout Salmo clarkii. Trans. Amer. Microscop. Soc. LXXI: 120-124.

Bulkley, Ross V. and Norman G. Benson. 1962. Predicting year class abundance of Yellowstone Lake cutthroat trout. U. S. Fish and Wildl. Serv., Bur. of Sport Fisheries and Wildl., Res. Rep. 59. 25 p.

Calhoun, A. J. 1944. Black-spotted trout in Blue Lake, California. Calif. Fish and Game 30: 22-42.

Carlander, Kenneth D. 1969. Handbook of freshwater fishery biology. Iowa St. Univ. Press, Ames, Iowa. 752 p.

Chamberlain, Thomas K. 1943. Research in stream management in the Pisgah National Forest. Trans. Amer. Fish. Soc. 72: 150-176.

Cole, Lamont C. 1954. The population consequences of life history phenomena. Quart. Rev. Biol. 29: 103-137.

Cooper, Edwin L. 1953. Returns from plantings of legal-sized brook, brown and rainbow trout in the Pigeon River, Otsego County, Michigan. Trans. Amer. Fish. Soc. 82: 265-280.

________. 1959. Trout stocking as an aid to fish management. Penn. Agr. Exp. Sta., Bull. 663. 21 p.

. 1970. Growth of cutthroat trout (Salmo clarki) in Chef Creek, Vancouver Island, British Columbia. J. Fish. Res. Bd. Can. 27: 2063-2070.

Cope, O. B. 1956. The future of the cutthroat in Utah. Proc. Utah Acad. 32: 89-93.

• 1957. Six years of catch statistics on Yellowstone Lake. Trans. Amer. Fish. Soc. 85: 160-179.

Davis, S. P. 1961. A limnological survey of the backwater of the lower St. Joe River, Idaho. M.S. Thesis, Univ. of Idaho. 69 p.

Dill, W. A. and Leo Shapovalov. 1939. An unappreciated California game fish, the Rocky Mountain whitefish, Prosopium williamsoni (Girard). Calif. Fish and Game 25: 226-227.

Drummond, R. A. 1966. The reproduction and harvest of cutthroat trout at Trappers Lake, Colorado. Colorado Dep. Game, Fish and Parks, Spec. Rep. No. 10. 26 p.

Dunn, C. 1968. St. Joe River creel census-1968. Idaho Fish and Game Dep., Completion Rep. 23 p.

El Hunt, R. 1952. Steamboats in the timber. The Caxton Printers, Ltd., Caldwell, Idaho. 209 p.

Falter, C. M. 1969. Digestive rates and daily rations of Nrthern squawfish in the St. Joe River, Idaho. Ph.D. Diss., Univ. of Idaho. 59 p.

Fleener, G. G. 1952. Life history of cutthroat trout (Salmo clarki) Richardson, in Logan River, Utah. Trans. Amer. Fish. Soc. 80: 235-248.

Godfrey, H. 1955. On the ecology of Skeena River whitefishes, Coregonus and Prosopium. J. Fish. Res. Bd. Can. 12: 499-527.

Gordon, Douglas. 1970. A survey of angler preferences, behavior and opinions. Idaho Fish and Game Dep., Proj. F-18-R-14. 106 p.

Hagen, H. K. 1958. A case for the native. Wyoming Wildl. 22: 31-37.

Hauck, Forrest R. 1959. Idaho trout trends. Idaho Wildl. Rev. 11: 6-9.

Hayden, Peter S. 1967. Studies on the ecology of the Snake River cutthroat trout. Wyoming Game and Fish Comm., Coop. Res. Proj. No. 4. 105 p.

Hunsaker II, Don, Leo F. Marnell and F. Phillip Sharpe. 1970. Hooking mortality of Yellowstone cutthroat trout. Prog. Fish-Cult. 32: 231-235.

Hunt, R. L., O. M. Brynildson and J. T. McFadden. 1962. Effects of angling regulations on a wild brook trout fishery. Tech. Bull. No. 26. Wisconsin Conserv. Dep., Madison, Wisconsin. 58 p.

Huston, Joe E. 1970. Investigations on Hungry Horse Reservoir, Montana. Montana Fish and Game Dep., Progress Rep., Proj. No. F-34-R-3. 11 p.

Irving, R. B. 1955. Ecology of cutthroat trout in Henry's Lake, Idaho. Trans. Amer. Fish. Soc. 84: 275-296.

Kormondy, E. J. 1969. Concepts of ecology. Prentice-Hall Inc., Englewood Cliffs, New Yersey. 209 p.

Laakso, Martin. 1951. Food habits of the Yellowstone whitefish, Prosopium williamsoni cismontanus (Jordan). Trans. Amer. Fish. Soc. 80: 99-109.

and O. B. Cope. 1956. Age determination in the Yellowstone cutthroat trout by the scale method. J. Wildl. Manage. 20: 138-153.

Lagler, Karl F. 1956. Freshwater fishery biology. Wm. C. Brown Co., Dubuque, Iowa. 421 p.

MacPhee, C. 1966. Influence of differential angling mortality and stream gradient on fish abundance in a trout-sculpin biotope. Trans. Amer. Fish. Soc. 95: 381-387.

________ and Richard Ruelle. 1969. A chemical selectively lethal to squawfish (Ptychocheilus oregonensis and P. umpquae). Trans. Amer. Fish. Soc. 98: 676-684.

Mallet, Jerry. 1961. Middle Frk of Salmon River trout fisheries investigation. Idaho Fish and Game Dep., Proj. F-37-R-2. 65 p.

Marnell, Leo F. and Don Hunsaker II. 1970. Hooking mortality of lure-caught cutthroat trout (Salmo clarki) in relation to water temperature, fatigue, and reproductive maturity of released fish. Trans. Amer. Fish. Soc. 99: 684-688.

Mason, John W. and R. L. Hunt. 1967. Mortality rates of deeply hooked rainbow trout. Prog. Fish-Cult. 29: 87-91.

McFadden, James T. 1957. Characteristics of trout angling at Lawrence Creek, Wisconsin. Trans. Wisconsin Acad. Sciences, Arts and Letters. 45: 21-29.

1969. Trends in freshwater sport fisheries of North America. Trans. Amer. Fish. Soc. 98: 136-150.

McHugh, J. L. 1940. Food of the Rocky Mountain whitefish, Prosopium williamsoni (Girard). J. Fish. Res. Bd. Can. 5: 131-137.

Miller, R. B. 1951. Survival of hatchery-reared cutthroat trout in an Alberta stream. Trans. Amer. Fish. Soc. 81: 35-42.

________. 1953. Comparative survival of wild and hatchery-reared cutthroat trout in a stream. Trans. Amer. Fish. Soc. 83: 120-130.

________. 1957a. Permanence and size of home territry in stream-dwelling cutthroat trout. J. Fish. Res. Bd. Can. 14: 687-691.

________. 1957b. Have the genetic patterns of fishes been altered by introductions or by selective fishing? J. Fish. Res. Bd. Can. 14: 797-806.

Miller, R. R. and J. R. Alcorn. 1945. The introduced fishes of Nevada with a history of their introduction. Trans. Amer. Fish. Soc. 73: 173-193.

Newell, Arthur E. 1957. Two-year study of movements of stocked brook trout and rainbow trout in a mountain trout stream. Prog. Fish-Cult. 19: 76-80.

Nikolsky, G. V. 1963. The ecology of fishes. Academic Press, New York. 353 p.

Ortmann, David W. 1969. Middle Fork of Salmon River investigations. Idaho Fish and Game Dep., Proj. F-56-R-1. 20 p.

Ricker, W. E. 1958. Handbook of computations for biological statistics of fish populations. Fish. Res. Bd. of Can., Ottawa. 300 p.

1968. Methods for assessment of fish production in fresh waters. Blackwell Scientific Publ., Oxford and Edinburgh. 313 p.

Robertson, O. H. 1947. An ecological study of two high mountain trout lakes in the Wind River Range, Wyoming. Ecol. 28: 87-112.

Rounsefell, George A., and W. H. Everhardt. 1953. Fishery science, its methods and applications. John Wiley and Sons, Inc., New Yrk. 444 p.

Shetter, D. S. and G. R. Alexander. 1965. Results of angling under special and normal trout fishing regulations in a Michigan trout stream. Trans. Amer. Fish. Soc. 94: 219-226.

Sigler, William F. and Robert Rush Miller. 1963. Fishes of Utah. Utah State Dep. of Fish and Game, Salt Lake City. 203 p.

St. Maries Courier (local newspaper, St. Maries, Idaho). Hist. Rev., 1901-1905.

Synder, G. R. and H. A. Tanner. 1960. Cutthroat trout reproduction in the inlets to Trappers Lake. Colorado Dep. Fish and Game, Tech. Bull. No. 7. 85 p.

Teague, R. D. 1968. Quality fishing programs. Fish Seminars, Univ. of California Agr. Ext. Serv. (Mimeo). 12 p.

Thompson, R. B. 1959. Food of the squawfish, Ptychocheilus oreqonensis (Richardson) of the lower Columbia River. U. S. Fish and Wildl. Serv., Fish. Bull. 60: 43-58.

Thorpe, Lyle M., H. John Rayner and Dwight A. Webster. 1947. Population depletion in brook, brown and rainbow trout stocked in the Blackledge River, Connecticut in 1942. Trans. Amer. Fish. Soc. 74: 166-187.

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